FOREST SCIENCE PROGRAM MISSION STATEMENT

To help provide innovative solutions to high-priority forest management problems in B.C. and to advance resource stewardship based on scientific principles.

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Message from the Chief Forester and the Assistant Deputy Minister, Operations

We are pleased to present the Forest Science Program Annual Report *for 2000/01. This report represents the third successive year in a renewed commitment to convey current information about the Forest Science Program and its activities.*

The projects and outcomes in this report represent the collective, cooperative efforts of Forest Science staff in Forestry Division and Operations Division. Together, they are helping to provide a credible, scientific foundation to support the first two strategic goals in the Ministry of Forests' Business Plan 2000–2001:

- *To manage and conserve forest and grassland ecosystems for sustainable use now and in the future.*
- *To ensure that the province's forest, range and associated recreation resources contribute to the economic well-being of its citizens and communities.*

The current and recently completed research projects outlined in this report complement a legacy of knowledge garnered over many decades of devoted efforts. With that wealth of information, British Columbia continues to be among the leaders in sustainable management of natural forests.

Larry Pedersen
Chief Forester
Assistant Deputy Minister, Forestry Division

Greg Koyl
Assistant Deputy Minister, Operations Division

Message from the Director

The 2000/01 fiscal year marks the Forest Science Program's first complete year of endeavours in the 21st century. It is an opportune time to re-examine the legacy carried forward from previous years, and to project where our primary program values and priorities lie for the future.

Since its inception in 1924, the Forest Science Program has supported the Ministry of Forests' broad and complex mandate to provide stewardship of Crown forest and range resources. The program provides the ministry (also known as the Forest Service) with ready access to in-house experts who can address technical and scientific issues. These experts have practical experience and intimate familiarity with operational and policy issues, and they can be relied on to pose the right scientific questions and find workable solutions.

As the Forest Service has decentralized its activities, the Forest Science Program has also gained a larger regional presence so that it can provide better scientific support for operational decision-making. One of the strategic planning goals in the late 1990s was to improve the integration and coordination of the headquarters and regional components of the program. The result is a more cohesive program with better communications and more efficient deployment of resources to respond to both policy and operational research needs.

A major challenge for the Forest Science Program has been to respond to ever-increasing demands from clients, both for improved knowledge in traditional research areas, and for expansion into new topics of investigation. While the demand for credible scientific information has grown, the collective resources of the science and technology sector have not kept pace. The response of the Forest Science Program has been to improve linkages to clients to ensure that the highest-priority needs are being addressed, and to develop partnerships with other science providers to make the best use of available resources.

Various client organizations, including councils, committees and partnerships, share a role in advising the Forest Science Program on priorities. At present, the program is responding by supplying genetically improved stock for the Tree Improvement Program, and growth and yield and site productivity estimates for Timber Supply Reviews and

silviculture investment decisions. It is also helping to build forest management strategies for partial cutting, vegetation management, streams and watersheds, wildlife habitat, soils and biodiversity.

Another challenge that faced the Forest Science Program in the 1990s was maintaining and operating five research stations. As important as these were in supporting research activities—especially in the earlier days, when seedling propagation and nursery technologies were being developed—the costs to operate them were too high in the face of diminished funding. In 2000/01, after the closure of three of these facilities, attention was focused on seriously needed upgrades and improved security at the two remaining research stations. Cowichan Lake and Kalamalka (in Vernon) are now fully functional and ready to serve priority needs in forest genetics and tree breeding.

Most commitments to multi-year projects for the Science Council of B.C., funded through Forest Renewal BC, were either completed or in final wrap-up during 2000/01. Management and staff turned their attention to defining priorities for new research. Some of that planning found its way into the Science Council of B.C.'s latest call for proposals; other parts were used to secure allocations from base budgets and other funding sources. Throughout these proposals, there was an emphasis on team projects that involve both headquarters and regional research staff. Clients were also strongly involved in defining priorities and designing projects.

Over the next decade and beyond, the Forest Science Program will continue to build on the effective relationships it has established with clients and other science providers. Our scientists have built a reputation for their intimate knowledge of forest management issues and the role that research can play in building credible, scientifically sound solutions. That knowledge, combined with long-term data that continue to be developed, will be shared with other science collaborators as we work toward a mutual goal of improved forest resource management.

Henry Benskin
Director, Research Branch

A zonal ecosystem in the ESSFxv2 zone at Dash Creek, 90 kilometres south of Alexis Creek, southwest of Williams Lake (Cariboo Forest Region). (For zone definitions, see page 51.)

Science to Support Ministry Priorities

The Ministry of Forests is responsible for managing and protecting B.C.'s timber, range and outdoor recreation resources. It carries out this responsibility for the best balance of short- and long-term economic, social and environmental benefits for all British Columbians.

The Forest Science Program contributes directly and indirectly to the ministry's objectives in a number of important ways:

- It expands the knowledge base for the production, sustainable management, and administration of timber supplies.
- It increases our understanding of how integrated management prescriptions can be achieved, and how the results will affect forest growth and yield.
- It refines models and analytical procedures that help improve predictions of the resource-production implications of different management options.
- It reveals new ways, through work in forest genetics and silviculture, to achieve higher productivity in future stands.
- It contributes to the design of management prescriptions to achieve a variety of resource management objectives across the land base.
- It provides a scientific foundation for forest practices related to hydrology, soils, terrain stability, and ecosystem and density management.
- It helps refine sections of the *Forest Practices Code of British Columbia Act* (and played a lead role in producing or contributing to many code guidebooks and training packages).
- It provides essential support for the chief forester in the Timber Supply Review process and decisions, principally by developing and applying growth and yield projection models.
- It contributes to the development and refinement of a variety of resource management policies and procedures.

For detailed information about Research Branch and regional Forest Science activities, publication lists, downloadable reports, and notes on current events and projects, visit the Forest Science Program website at www.for.gov.bc.ca/forsci

Program Priorities

In B.C., research in the forest sciences is coordinated and guided by a number of committees, advisory boards, councils and partnerships. The Forest Science Board and advisory groups are the most significant in integrating external and internal requests for services, and in guiding the priorities and direction of the Forest Science Program.

The Forest Science Board is an internal, inter-divisional body that reviews the annual plans and performance of the Forest Science Program. It then makes recommendations about program priorities. The director of the Research Branch provides Forest Science Program leadership at the provincial level and presents both branch and regional forest science accomplishments to the board.

Regional Forest Science Advisory Groups set priorities and provide direction for regional operations. The headquarters advisory process is delivered informally, through an ongoing working relationship between Research Branch managers and client managers in other branches.

Vegetation assessments and measurements 10 years after glyphosate treatments, at Mile 73 near Fort St. John (Prince George Forest Region).

Organization

The Forest Science Program is, above all, collaborative. The program is made up of the Research Branch, within Forestry Division, and six regional Forest Science Teams within Operations Division. Operations and support staff in regional and district offices, other branches of the ministry, and external partners all provide invaluable assistance and contribute to the work of the program.

Research Branch researchers work closely with policy-makers and the ministry executive in Victoria to provide a solid science foundation for policy development. Together with regional researchers, they undertake innovative research and provide technical support to regional and district operations staff to help them resolve complex operational issues associated with Forest Practices Code interpretation and implementation, silviculture, growth and yield, and timber supply. Regional scientists also advise on emerging front-line issues, often in partnership with the Research Branch, licensees, universities, the Canadian Forest Service, and others.

Clients and Partners

The Forest Science Program has a mix of internal and external clients. Internal clients, who make up the majority, include the ministry executive and senior management, professional and technical specialists, and operational staff at all levels. External clients include other ministries, licensees, other research organizations, public agencies, private industry, and the public.

To meet the program mandate of supporting ministry priorities, Forest Science Program staff meet both client requests for short-term problem solving and advisory services, and the ministry's corporate needs in anticipating and addressing emerging issues and opportunities through research. The program therefore responds to a broad range of client demands, from providing information and technical advice, to designing and implementing complex research projects.

Research activities are also influenced by the formation of scientific partnerships and the availability of external funding. The Ministry of Forests is a major partner

science to support sustainability

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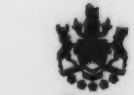


BRITISH COLUMBIA

Ministry of Forests

in the Southern Interior Forest Extension and Research Partnership and the Northern Forest Research and Extension Partnership. Both organizations are working to incorporate research results into operational practice, improve information sharing, and build cooperation among research organizations and the resource management community. Partners come from government agencies, industry associations, natural resource companies, First Nations groups, non-governmental organizations, Forest Renewal BC, and colleges and universities.

Funding and Expenditures

Forest Science Program expenditures in 2000/01 remained constant from 1999/00, at $20.7 million. As illustrated in Figure 1, funding came from internal vote funds (55%) and external sources, mainly Forest Renewal BC (45%).

Ministry-voted funding covered primarily essential fixed costs (i.e., mostly staff salaries, facilities maintenance, and a minimal amount of operating costs). Forest Renewal BC funding provided close to 78% of the overall operating funding for the program.

The provincial Forest Science Program supported the equivalent of 187 full-time positions in 2000/01. For the Research Branch, 54 researchers work in a range of scientific disciplines to address headquarters and provincial priorities. On a regional basis, 49 scientists also cover a variety of specialities and work closely with regional and district clients. Forest Renewal BC funded 38 of the program's positions.

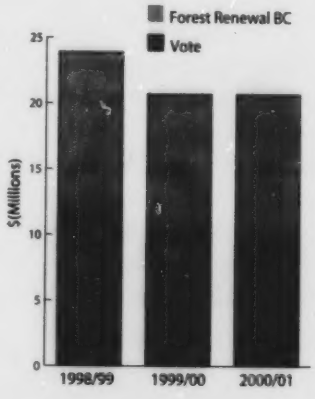


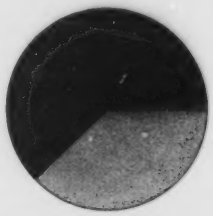
FIGURE 1 Forest Science Program Expenditures 1998–2001

The division of expenditures across the major activity areas remained relatively the same as it was in 1999/00: regional resources were concentrated on local operational issues such as ecosystem management, soil disturbance, watershed management, and terrain stability, and demonstrating and testing silvicultural systems. Research Branch expenditures went to programs that are more provincial in scope, such as growth and yield, genetics, and tree improvement. Additional activities in ecology, silviculture, and earth sciences are undertaken by both the regions and Research Branch to support policy development and resource management.

Research and development work is also conducted by other sections of the ministry (e.g., by Forest Practices Branch, among others) in addition to the work undertaken within the Forest Science Program. Details of those expenditures and accomplishments are not included in this annual report.

Total Forest Science Program, $20.7M

Research Branch, $13.9 M



Regional Research, $6.8 M

FIGURE 2 Forest Science Program Funding 2000/01

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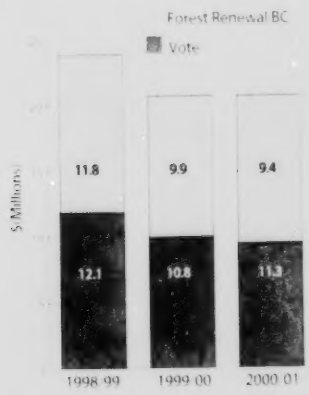

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Forest Science Program researchers contributed to the Cariboo-Chilcotin Land-Use Plan Grasslands Strategy by providing technical advice on forest encroachment.

Funding Trends and Initiatives

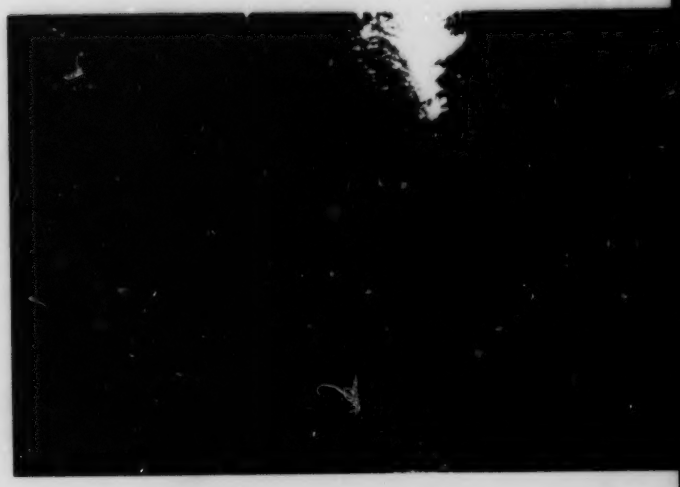
Forest Science Program staff submitted 77 proposals to the Forest Renewal BC Research Program for funding in 2001/02. Although it is anticipated that some proposals will be successful, the overall budget for that program decreased to $14.5 million. Funding through other Forest Renewal BC programs is expected to be maintained at levels similar to those in 1999/00.

Internally, the Forest Science Program continued to reduce overhead costs in 2000/01. The Red Rock Research Station was closed, and cost recovery from service users continued for the Research Laboratory and the Cowichan Lake Conference Centre.

The Value of Long-Term Forest Research

The longevity of forest trees creates a need for equally long-term studies of forested ecosystems. When harvest rotations are planned to exceed a human lifetime, observations and measurements of change can span generations. Today, forest managers are benefiting from the foresight of their predecessors in the early and mid-1900s, who began research projects that are still generating data and contributing to our knowledge today. We expect that more-recently established long-term studies will benefit future researchers in similar ways.

Ongoing interest in the sustainability of forest practices in Canada has led to the establishment of more than 20 long-term silvicultural research sites across the country in the past 10 years. As the need for information about Canada's forest practices increases, the value of these long-term research sites continues to grow.



This photo of a fish weir on Carnation Creek on the west side of Vancouver Island (Vancouver Forest Region) was taken in 1973, prior to harvesting treatments.

In B.C., the history of forestry research is closely associated with the establishment of long-term installations. There are well-established sites in the province that illustrate ongoing research on a variety of long- and short-term issues in several forest science disciplines—silviculture, growth and yield, ecology, earth sciences, and forest genetics. The sites are also used as outdoor classrooms by undergraduate students and practising resource managers, and by graduate students for more extensive research.

Long-term sites are also excellent for developing and testing hypotheses, implementing management treatments, and eventually demonstrating end-results management through continuous monitoring. The resulting data allow researchers to verify scientific interpretations and establish a foundation for future scientific investigations.

The application of long-term studies has substantially affected forest management and policy in B.C. For example, the British Columbia Coastal Fisheries Forestry Guidelines, *first implemented in 1987, were based largely on information from the Carnation Creek Watershed Study (see page 11). Knowledge gained at Carnation Creek has subsequently been used to support the development of forestry regulations, environmental standards, and best management practices within the British Columbia Forest Practices Code. The code replaced the* Guidelines *in 1995 and applies to the entire province. Five code guidebooks are based at least partly on Carnation Creek results.*

A stand of second-growth Douglas-fir in the Schenström plots at the Cowichan Lake Research Station (Vancouver Forest Region). The stand was probably established around 1909.

There are many other examples of the benefits of long-term research—even unseen benefits. One is a series of maps of fallen trees generated by foresters at the Cowichan Lake Research Station in 1929 (see page 12). Those foresters would not have anticipated the present-day utility of long-term log decay information afforded by their study, but that information has contributed to the development of current forest practices for the management of coarse woody debris (CWD). Recent remeasurements and remapping have given researchers information that has been invaluable for understanding the role of CWD in coastal ecosystems. Similarly, the forest genetics provenance trials that were established in the 1960s, which were designed to measure species performance, have recently proven to be extremely valuable as genetic repositories of heritable pest-resistance traits (see page 13).

Partnerships are a common feature of many long-term research installations, because they provide an effective and economical use of resources and offer diverse expertise and perspective to the research. Most existing long-term studies would not have been possible without the help and cooperation of other agencies. Participation by B.C. researchers in international cooperative projects contributes to the credibility that is increasingly important in certification and other global resource issues. The Long-Term Soil Productivity Study is a good example not only of B.C.'s international cooperation, but of the Forest Science Program's goal of optimizing the use of staff and funding resources locally and internationally by sharing information with a wide range of partners (see page 14).

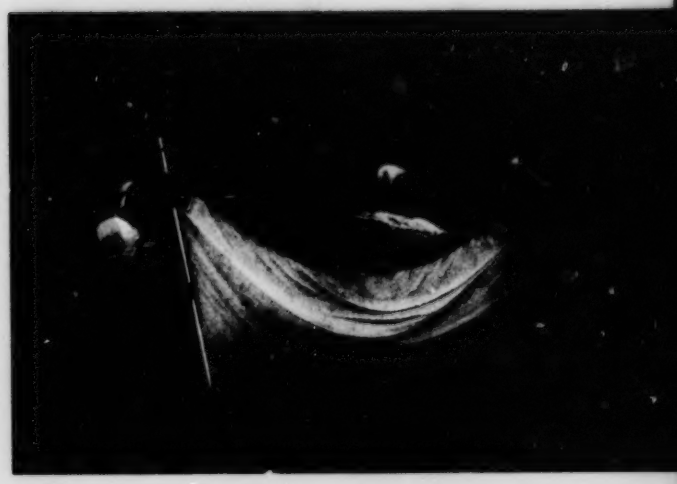
Long-term studies can bring numerous benefits, but only through long-term commitment. The installation of a long-term research site requires considerable planning and coordination. But that's just the beginning. After researchers have established the site, long-term information management systems must be developed so that data can be retrieved and used decades later. In the field, researchers must continue to take regular measurements and remeasurements to preserve the continuity of data and the integrity of the datasets for analytical purposes. The job of site upkeep includes registering research sites to ensure that resource managers are aware of the nature and location of the installations and do not inadvertently disrupt them. The job also includes regular brushing and ongoing security, as well as maintaining fences and signs.

Long-term studies provide concrete results to help refine forest practices, regulations and guidebooks, which can translate into better and more cost-effective management of the forest over time.

Results to date, and the benefits that have accrued, validate the effort that has gone into the design, implementation and maintenance of our long-term installations. They have resulted in an increasing awareness that sustainable forest resource management must be informed by an intimate and continuously improved understanding of long-term forest ecosystem dynamics.

Carnation Creek: Fish and Forestry

The single-watershed, intensive case study at Carnation Creek on the west coast of Vancouver Island has generated the longest series of continuous data on fish/forestry interactions in North America. The effects of forest harvesting on watershed processes and fish populations have been studied there for more than 30 years. The results have made landmark contributions to both our understanding of the effects of forest harvesting on watershed processes, and the development of the hillslope, stream channel, and riparian management standards and guidelines of the B.C. Forest Practices Code.



In Carnation Creek on the west side of Vancouver Island (Vancouver Forest Region), a crew does a summer survey of juvenile populations of coho salmon, rainbow trout and cutthroat trout.

The Carnation Creek Watershed Study was initiated in 1970 by the federal agency now known as Fisheries and Oceans Canada. The study soon expanded into a multi-agency, multidisciplinary program studying the effects of forest harvesting on a coastal watershed and its salmon and trout populations.

In the 1960s, resource managers used studies conducted elsewhere in North America—such as in Oregon, Alaska, and even New Hampshire—to predict the effects of logging on B.C. fish populations. These extrapolations could not be applied with confidence to planning decisions for areas on the west coast of B.C., so the Carnation Creek study was initiated to provide fish/forestry information on at least one type of drainage basin in coastal B.C.

There were three main objectives in the Carnation Creek study. First, researchers wanted to develop an understanding of the physical and biological processes operating within a coastal watershed. Second, they wanted to know how the forest harvesting practices employed in the 1970s and early 1980s changed these processes. Finally, resource managers wanted to incorporate the results of the study into their decision-making about land-use management, fish populations, and aquatic habitat protection.

The project has achieved all three of those goals, despite the fact that the logistics of such an intensive project limited studies to a single watershed. Even with that limitation, the depth, duration and comprehensiveness of the work has led to a refined understanding of processes governing fish/forestry interactions. In applying that understanding to decisions in other watersheds, researchers and resource managers continue to build an additional body of experience and empirical evidence to support management of watersheds across B.C.

The Schenström Plots: A 70-Year Legacy

Stig Schenström circa 1929 at the Cowichan Lake Research Station. It is said that the Cowichan Lake site was chosen for the Douglas-fir growth and yield plots because of the excellent fishing nearby.

Stig Schenström joined the Research Branch of the B.C. Forest Service in 1929, just two years after graduating from the Royal College of Forestry in Stockholm. His time with the branch was short—he departed in 1931—but his legacy is still important seven decades later.

With other researchers, Schenström established six permanent experimental plots at the Cowichan Lake Research Station in 1929 and 1930 to test the effects of four different intensities and types of thinning in young Douglas-fir forests. These were the very first thinnings of Douglas-fir in coastal B.C. Since then, seven major thinning treatments have been carried out, and 15 remeasurements have been made. The Schenström plots form the longest-term demonstration of the effects of thinning on conifer stand growth in coastal B.C. The data from these experimental plots are also used to validate growth and yield models such as TASS and Prognosis^{BC}. Results from these models are applied in the Timber Supply Review to help determine annual allowable cuts.

Schenström measured all of the trees in each plot. He also created a number of subplots. In these, he numbered and mapped the trees, but he also did something quite out of the ordinary: he mapped and measured all of the coarse woody debris (CWD). Later researchers numbered the remaining trees outside of the subplots. The results show how the different thinning regimes affect the number and size of trees, the volume of standing timber, and total wood production.

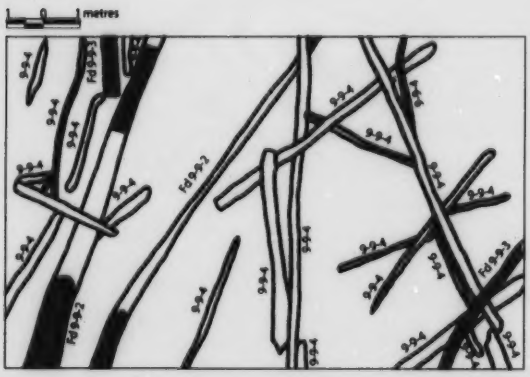


FIGURE 3 A hand-drawn map showing outlines of fallen logs as they appeared in 1929□ and 1996■ in the Schenström plots at the Cowichan Lake Research Station.

When long-term projects are initiated, it is difficult to foretell future applications of the findings, or to anticipate all of the useful sets of data that should be gathered. Inclusion of CWD measurements in the Schenström plots was a fortuitous event that has paid long-term dividends. The periodic remapping and remeasuring of CWD has allowed later researchers to construct decay models to explain the gradual, natural disappearance of different-sized CWD pieces (see Figure 3 this page). Using these models, researchers and resource managers have developed a better understanding of how changes in CWD over time will affect structural diversity in forests. This information has, in turn, provided valuable insight into the ability of forests to provide habitat for plants, mammals, amphibians, insects and micro-organisms.

Long-Term Provenance Trials: More Than Expected

Forty years after they were installed, long-term provenance trials are yielding valuable information about disease resistance and other traits. For example, tree breeders use information from the trials on natural pest/host plant relationships to achieve durable resistance to insects and diseases. It's hard to say whether the researchers who planted the trees anticipated a need for this type of knowledge at the time. But fortunately, since later researchers have carefully maintained the field installations and made periodic remeasurements of important biological variables, we now have a known base on which to build subsequent studies.

Lodgepole pine is commonly attacked by a variety of pests, such as needle cast, western gall rust, blister rust, and sequoia pitch moth. The damage can be so severe that it wipes out the gains expected from tree improvement and intensive silviculture. In 1993, researchers turned to a previously established network of 71 provenance test sites throughout B.C., which were first established in the mid-1960s, made up of nearly 200 lodgepole pine provenances from a wide variety of geographic locations. These sites offered an effective and inexpensive opportunity for researchers to evaluate how genetic and site factors affect the pest resistance of lodgepole pine plantations. The trials were systematically assessed, and a number of natural populations were identified as having naturally occurring pest resistance. These resistant populations are the primary sources for the selection of parents to build improved pest resistance in future generations of trees.

This fast-growing six-year-old lodgepole pine seedling was photographed in 1966 at Muir Creek near Sooke on southwestern Vancouver Island (Vancouver Forest Region). This location is one of 71 lodgepole pine provenance test sites in B.C.

Long-Term Soil Productivity: Working Together

Forest Science Program researchers are collaborating in the international, multiple-site Long-Term Soil Productivity Study to investigate how compaction and the removal of organic matter affect the properties and biology of soils.

Ministry of Forests researchers are collaborating in the international Long-Term Soil Productivity Study. This project is the world's largest coordinated effort to study the effects of soil compaction and organic matter loss on soil productivity. B.C. participated because early indications from research elsewhere suggested that site productivity might be adversely affected by some standard forestry operating procedures.

Numerous sites have been established in B.C. and Eastern Canada, and throughout the United States, with the cooperation of provincial, federal, university, and private-sector scientists (Figure 4). Sites in B.C. were selected to include a broad spectrum of soil, climate and ecological conditions, to ensure that results may be extrapolated to a wide range of situations.

There are a number of important strengths to this cooperative effort. Sound experimental designs are being used in all affiliated field experiments. Uniform measurement protocols have been adopted, and all investigators are willing to share data and findings. Testing in a controlled experiment provides a fundamental calibration of disturbance effects.

The study also offers considerable benefits:

- Researchers will be able to use data from the study to develop and refine practical decision aids, such as a risk-rating system based on soil disturbance hazard keys, and soil disturbance measurement criteria.
- The study's soil productivity results will be used in Timber Supply Reviews.
- Results from the study are used by Ministry of Forests districts and by licensees to determine windows of operability for field work.
- Associated local research in soil conservation and rehabilitation, coarse woody debris, and root rot treatments will help improve the technical foundations for best management practices and for Forest Practices Code standards and guidelines.
- Conducting internationally accredited research will help make B.C. more competitive in the greener global market.
- It expands our network of field sites and researchers.
- It established links between experimental and operational treatments, which makes the study directly relevant to forest operations.

The Long-Term Soil Productivity Study is designed to continue for longer than a full timber harvesting rotation. This makes the results especially valuable for understanding the effects of forest practices over the time frames required for forest management relative to the growth of long-lived organisms, such as trees. The study will help ensure that current and future forest practices conserve B.C.'s valuable soil ecosystems and maintain site productivity.

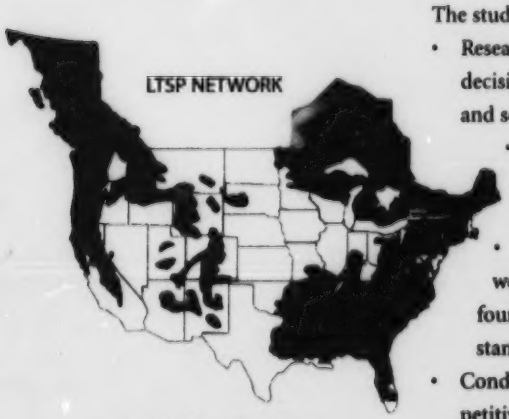


FIGURE 4 Location of Long-Term Soil Productivity Study sites in North America.

Core Sites ●
Affiliated Sites ▲
Forested Area ■

Silviculture

SILVICULTURAL SYSTEMS

Background

Silvicultural systems research examines the consequences and implications of using alternative harvesting and forest regeneration strategies to meet more diverse forest objectives. These alternatives to conventional clearcut harvesting are driven by a growing appreciation of the ecological complexity of forests, and of the non-timber values associated with them.

Summary

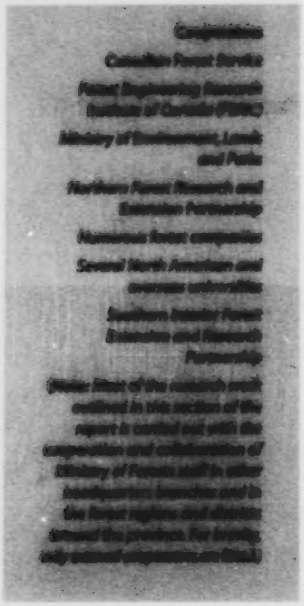
Silvicultural systems research consists of approximately 20 multi-disciplinary projects located throughout B.C.'s forest regions. These projects include Roberts Creek (Vancouver Forest Region), Date Creek and HyP^3 (Prince Rupert Forest Region), Opax Mountain and Sicamous Creek (Kamloops Forest Region), Itcha-Ilgachuz and Quesnel Highland (Cariboo Forest Region), as well as several others in each of the Nelson and Prince George forest regions. In addition, a new project (Silviculture Treatments for Ecosystem Management) has recently been initiated in the Sayward Forest near Campbell River (Vancouver Forest Region).

Some examples of specific silviculture issues being addressed at the landscape level include the use of alternative silvicultural systems to enhance caribou habitat and in sensitive watersheds, root rot areas, viewscapes, boreal mixedwood forests and high-elevation forests. Other examples of issues at the stand level are the effects of alternative silvicultural systems on regeneration, the growth and productivity of trees, understorey plants, mosses, mycorrhizal fungi, mushrooms, seed abundance, hydrology, and songbirds and other animals.

The STEMS (Silviculture Treatments for Ecosystem Management in the Sayward) study is examining the effects of seven silvicultural methods that emulate patterns of natural disturbance.

Results or products

This year was very productive for silvicultural systems extension activities. Researchers published 11 journal articles, seven extension notes, two technical reports, two working papers and 11 theses. They also made 12 conference presentations and guided



more than 40 field tours. Current study results are available at the regional and Research Branch websites (see "How to Contact Us," page 52).

MIXEDWOOD MANAGEMENT

Background

The ministry has an ongoing need for resource management information, which it uses to continue to refine its free-growing guidelines and manage stands that include mixtures of broadleaf and conifer species. Mixedwood research helps meet these needs. Forestry managers use these research results to develop alternative silvicultural systems for managing boreal mixedwoods; for example, by underplanting mature aspen stands with white spruce.

Summary

In several interrelated studies, researchers are investigating regeneration and stand-tending options in the management of mixed-species stands in the wetbelt region of the southern interior, and in the northern boreal forest. These studies include regeneration, stand-tending and density experiments. They also include retrospective modelling and below- and above-ground process studies.

Results or products

Results of this research were discussed during 2000/01 at various management, technical and scientific forums. Researchers also published extension notes, produced computer tools and held workshops.

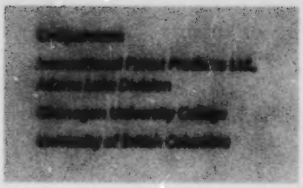
Researchers from the Prince George Forest Region published a working paper on the seven-year results of spruce seedling performance after white spruce had been planted under trembling aspen. Results indicate that mature aspen stands represent a less hostile environment for planted seedling establishment than clearcuts, but long-term performance is superior in clearcuts. Trees planted under mature aspen had a survival rate of 94% and acceptable performance, based on current ministry growth-performance standards.

The results of northern boreal forest research done by the Forest Science Program helped the ministry and Slocan Forest Products Ltd. develop a Memorandum of Understanding this year on mixedwood management.

Ministry researchers presented current research in boreal and Interior Cedar–Hemlock (ICH[1]) mixedwoods, and discussed its application to free-growing standards, at the joint Northern Silviculture Committee–Northern Interior Vegetation Management Association meeting (attended by more than 250 participants) in Prince George. Researchers also made presentations at the Ontario Ministry of Natural Resources Mixedwood Expert Session in Thunder Bay, and at the Alberta Advanced Forest Management Institute in Hinton.

In posters at the winter meeting of the Southern Interior Silviculture Co-operative

in Penticton, researchers presented results related to meeting free-growing standards, setting mixedwood stocking standards and developing techniques for managing ICH mixedwoods. ICH-mixedwood research was also summarized at the ICH Research Summit in Kamloops, and in a seminar at the University of British Columbia.



VEGETATION MANAGEMENT

Background

The goal of forest vegetation management research is to help ensure successful establishment and maintenance of reforested areas to a free-growing stage while protecting other public forest resources. Researchers study options such as physical and biological vegetation control methods, and herbicide treatments. Results are used by resource managers to develop more cost-effective, environmentally sound and socially acceptable vegetation management prescriptions.

Researchers and resource managers also evaluate long-term growth and yield implications of vegetation management treatments. These studies contribute to our understanding of stand dynamics, development and structure. They also provide valuable information to address various forest management issues, such as free-growing requirements, mixedwood stocking standards, green-up, and the conservation of biodiversity.

Nine-year-old planted spruce under a 70-year-old aspen canopy near Dawson Creek (Prince George Forest Region). Planting spruce seedlings beneath a mature aspen stand provides a viable silvicultural alternative for managing mixedwood stands.

Summary

During 2000/01, vegetation management researchers in the regions and branches established the following new projects:

- EXPLORE (EXperimental design Protocol for Long-term Operational Response Evaluations) installations in the Dawson Creek, Fort St. James, Fort St. John and Prince George forest districts (Prince George Forest Region) to study the long-term effects of glyphosate treatments on spruce growth, stand and vegetation community dynamics, and achievement of free-growing status.
- A study at Boundary Lake (Kootenay Lake Forest District, Nelson Forest Region) to control Sitka alder at a backlog site by using the fungus *Chondrostereum purpureum* as a biocontrol agent.
- PROBE (PRotocol for Operational Brushing Evaluations) installations in the Kamloops and Nelson forest regions to evaluate the effects of operational brushing treatments on conifer survival and growth, vegetation height and cover, competition thresholds, and plant diversity.

Researchers continued work this year on multi-year projects, including those at:

- Bongard Creek, Homestead Road, Wikiup Creek and Rushton Creek (Kamloops Forest Region) to determine the optimum brushing radius of neighbouring vegetation, particularly paper birch, for the best performance of the Douglas-fir, lodgepole pine, or paper birch (fourth year),
- a mine site near Grand Forks in the Boundary Forest District (Nelson Forest Region) to evaluate the effectiveness of *Chondrostereum purpureum* as a biocontrol agent to control trembling aspen in lodgepole pine stands (fifth year),

Cooperators

Canadian Forest Service

Forest Engineering Research Institute of Canada (FERIC)

Ministry of Environment, Lands and Parks

Northern Forest Research and Extension Partnership

Numerous forest companies

Several North American and overseas universities

Southern Interior Forest Extension and Research Partnership

(Note: Most of the research work outlined in this section of the report is carried out with the cooperation and collaboration of Ministry of Forests staff in other headquarters branches and in the forest regions and districts around the province. For brevity, only external cooperators are listed.)

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Cooperators

International Forest Products Ltd., Adams Lake Division

Okanagan University College

University of British Columbia

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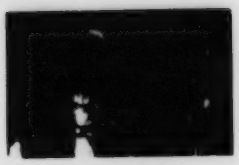
- a Nahatlatch River site near Boston Bar (Chilliwack Forest District, Vancouver Forest Region) to compare the effectiveness of glyphosate, hexazinone, and porous mulch mats for reducing grass competition and improving the survival and growth of Douglas-fir seedlings (seventh year),
- two sites in the Murray Creek drainage near Spences Bridge (Kamloops Forest Region) to examine the effects of mechanical and chemical patch site preparation treatments on steep, dry, grassy slopes in the Interior Douglas-Fir (IDF)dk2[1] zone (eighth year), and
- North Adams Lake, Hidden Lake and Malakwa (Kamloops Forest Region) to test a range of tree species combinations (i.e., paper birch, Douglas-fir, western larch and western redcedar), tree densities, stand performance, environmental conditions, and mycorrhizal diversity and function (ninth year).



Top Common witch's hair (*Alectoria sarmentosa*) is an important food source for caribou.

Bottom Modified harvesting approaches maintain caribou habitat without interrupting the timber harvest.

Cooperators

Canadian Forest Service
Forest Renewal BC
International Forest Products Ltd.
JH Huscroft Ltd.
University of Alberta

Results or products

During 2000/01, vegetation management researchers in the regions and branches produced a variety of publications on the effects of glyphosate, *Chondrostereum purpureum* brushing treatments, thinning, and repeated manual cutting (see the publications list, page 43).

Forest managers used the reported manual cutting information to develop silviculture prescriptions. Information was also used by the Forest Practices Branch during a pesticide-use permit appeal process.

Forest managers have used information from the studies of the long-term effects of glyphosate treatment on stand development to refine free-growing standards and develop mixedwood stocking standards. An expert committee on weeds and weed control has also requested a presentation on those long-term effects.

The application of *Chondrostereum purpureum* to brushed trembling aspen suckers had little effect on aspen resprouting. This suggests that there is little reason to use *C. purpureum* to manage aspen suckers in conifer plantations.

Vegetation assessments and measurements 10 years after glyphosate treatments, at Tsilcoh River near Fort St. James (Prince George Forest Region).

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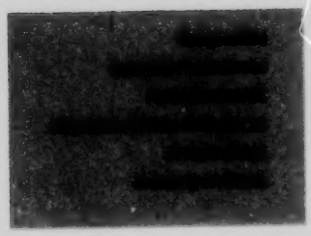

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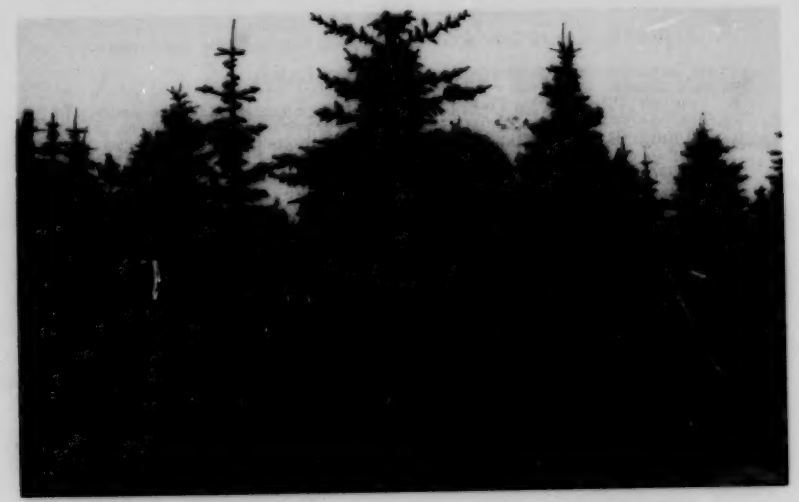

Vegetation assessments and measurements 10 years after glyphosate treatments, at Tsilcoh River near Fort St. James (Prince George Forest Region).

Growth and Yield

STAND MODEL DEVELOPMENT

Background

Forest practices are changing rapidly, as resource management shifts away from traditional clearcutting toward silvicultural systems such as partial cutting and variable retention, which generate more complex stand structures. Since very few long-term data exist for complex stands, growth and yield researchers are developing or updating models to realistically project their structures over time.

Summary

During 2000/01, researchers revised and expanded existing models, including the Tree and Stand Simulator (TASS), Prognosis^{BC} and SORTIE.

SORTIE simulates boreal aspen-spruce prescriptions that retain complex stand structures, such as in this strip-cutting harvest, in which understorey white spruce is retained.

TASS

Researchers collected three types of data to develop new coefficients and equations for the model:

- Data from dissected trees were analyzed to provide new predictive equations for uneven-aged Interior Douglas-fir, larch, paper birch and red alder.
- Trees were remeasured in permanent sample plots installed in complex stands.
- Specialized data—such as leaf area, light distribution, soil moisture, water use, and natural regeneration processes—were collected to test new predictive models for complex stands. Using this information, the TRAYci light-simulation model, which is linked to TASS, was verified at a mixed-species Interior Cedar–Hemlock (ICH) research site.

Prognosis^{BC}

Researchers have developed and are testing new growth and mortality equations for the IDF[1] and ICH zones. They have also developed a method to predict regeneration under partial canopies in the ICHmw2 zone. It is currently being applied in a related study in the IDFdk1, IDFdk2 and IDFdk3 zones. Field sampling continues in the IDFdk4, IDFxm and IDFdm2 zones.

SORTIE

Two studies were completed this year which will help resource managers make more reliable predictions of seedling recruitment and tree growth. In those studies, researchers:

- used the number and size of parent trees, and the abundance and quality of seedbed substrates, to predict the number and spatial distribution of seedlings of each tree species, and
- incorporated species-specific growth functions for juvenile trees to account for past periods of suppression and release—a critical element in predicting complex stand dynamics.

Researchers also launched a new study, on tree competition indices. The results will help resource managers more accurately predict adult tree growth rates after natural disturbances or partial cutting.

Results or products

TASS

Using the coefficients developed for these new species, researchers will be better able to simulate the dynamics of single-species, uneven-aged stands.

Growth and mortality equations were developed for the Prognosis^{BC} model for IDF and ICH zones. Douglas-fir veterans in an IDFdk3 stand west of Williams Lake (Cariboo Forest Region) are an example of the stand types and harvest systems for which Prognosis^{BC} is being calibrated.

Two journal papers on water use and root elongation of interior Douglas-fir were published this year from data collected at Pothole Creek.

Prognosis^{BC}

Researchers made several improvements to the model this year:

- They developed new large tree (i.e., >7.5 centimetre [cm] diameter at breast height [dbh]) diameter and height growth functions for IDF and ICH zones in the Nelson and Kamloops forest regions and the Cariboo IDFdk3 zone.
- For the first time, they incorporated growth and mortality functions for broadleaved species.
- They developed functions to predict regeneration and growth of small trees (i.e., <7.5 cm dbh) in the ICHmw2, IDFdk1, IDFdk2 and IDFdk3 zones.

SORTIE

Currently, research is underway to calibrate and modify the model for use in the following forest types: temperate hardwood forests of southern Quebec, boreal mixedwood forests of the clay belt of Quebec and Ontario, spruce-aspen boreal forests of Canada, temperate forests of New Zealand, and tropical forests of Puerto Rico. The calibration of SORTIE for biomes (i.e., major ecological communities) of the boreal forest of Canada is part of an extensive research program in boreal forests initiated by the Sustainable Forest Management Network (http://sfm-1.biology.ualberta.ca).

STAND MODEL APPLICATIONS

Cooperators

TASS

Yale University

Prognosis^{BC}

Inland Timber Management Ltd., Williams Lake

Riverside Forest Products Ltd., Williams Lake

University of British Columbia

Background

Applying models helps resource managers select silviculture treatments to achieve future harvest goals in volume, value, habitat and employment. Managers and policy-makers also use applied results to support timber supply analyses and determinations of allowable annual cuts.

Summary

This year, researchers used the TASS model to generate yield projections to support silviculture planning in 10 timber supply areas and tree farm licences. Specialized model projections were also used to help design a variable retention harvesting field experiment, and to predict the occurrence and effects of mortality from pine rust,

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Results or products

[redacted]

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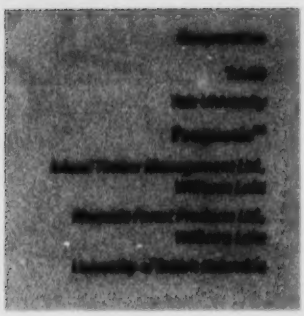

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the movement of spruce weevils, habitat for spotted owl, the damage from cattle, the sequestration of carbon, and the spatial distribution of regeneration.

Results or products

Foresters use applied growth and yield models to incorporate an understanding of stand dynamics into management practices. The application of these models has also helped the ministry develop silviculture strategies, improve silviculture practices, estimate timber supply and determine allowable annual cuts.

The Table Interpolation Program for Stand Yield (TIPSY) version 3.0 was released this year, with added capabilities for estimating the effects of genetic gain, commercial thinning, and clumped regeneration. The model can now also predict economic benefits and job creation, as well as provide customized yield tables. Resource managers have applied TIPSY extensively throughout the province in support of timber supply projections and silviculture plans and strategies. For example, in the Arrow Timber Supply Area, yield predictions from TIPSY show that long-term yield will increase by about 5% if all suitable sites are planted with improved genetic stock.

Douglas-fir regeneration in an IDFdk3 stand.

SITE PRODUCTIVITY MODEL DEVELOPMENT

Background

Researchers study site productivity to generate better site index and stand height information for forest resource management. Site index, which is a measure of site productivity, is an important parameter in forest management planning. It is principally used to estimate stand height and, subsequently, stand growth and yield. Growth and yield estimates are important for timber supply planning, developing silviculture prescriptions, updating inventories, and other forest management activities.

Summary

Site productivity is determined by sampling trees in designated stands. In one project this year, researchers studied the most efficient way to select sample trees when working in young stands. Results showed that selecting trees based on diameter was slightly faster than selecting trees based on height.

Cooperators

Louisiana Pacific Corp.

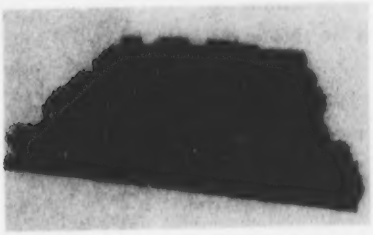
University of British Columbia

Results or products

During 2000/01, researchers in site productivity model development produced:

- coastal Douglas-fir juvenile height growth models,
- site-index conversion equations for mixed trembling aspen–white spruce stands,
- black spruce and western larch height-age/site-index models,
- black spruce growth intercept models, and
- a procedure for checking growth intercept models.

The results of these projects will contribute to better estimates of site index and height, and, consequently, to better growth and yield estimates (see the publications list, page 42, for a list of studies published during 2000/01).



TASS simulations were used to help design variable retention harvest treatments in the STEMS (Silviculture Treatments for Ecosystem Management in the Sayward) study.

The STEMS study is examining the effects of silvicultural methods that emulate patterns of natural disturbance.

Ecology

ECOSYSTEM CLASSIFICATION

Background

Classification of B.C.'s ecosystems is essential for the long-term management and conservation of forest and range land ecosystems. The Biogeoclimatic Ecosystem Classification (BEC) System provides a framework for these purposes. The classification is an integral component of management interpretations and planning in forest, range and wildlife management. The standardized codes and names for BEC units are used for many applications, including software, spatial and non-spatial data, and modelling tools such as Prognosis[BC].

Within BEC, site-series (ecosystem) classifications are available for most forested areas of the province. As forest harvesting activities proceed into previously inaccessible or remote locations, the need increases to extend and improve classifications of those areas. Wetland and Riparian Ecosystem Classification (WREC) provides baseline information on wetland and riparian ecosystems and for the Forest Practices Code *Riparian Management Area Guidebook*.

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Summary

During 2000/01, researchers completed field sampling to provide site-series classifications of previously unclassified and formerly inaccessible areas in several districts of the interior. Those included subalpine ecosystems of the south Chilcotin ranges (ESSFxv2[1]) and southern Prince Rupert Forest Region, the southeastern portions of the SBSmw, the Merritt, Lillooet, Kamloops and Okanagan forest districts, and early seral ecosystems in the Bulkley Valley. Researchers also published field guide supplements to cover the ESSFxv2 and hardwood-dominated ecosystems in the SBSdk and ICHmc2 of the Prince Rupert Forest Region, completed a revised site-series classification for the SBSmw and 15 other biogeoclimatic units in the southern interior, finished an introductory review of *Rare Ecosystems of the Lillooet Forest District* and published *The Ecology of the Mountain Hemlock Zone* online.

Researchers have added new site associations for the north coastal wetlands and interior riparian cottonwood ecosystems, and the wetland and provincial forested classifications have now been integrated to improve the accessibility of ecological information. The wetland classification was also showcased during a week-long north coast tour and conference attended by a group of international wetland scientists.

Results or products

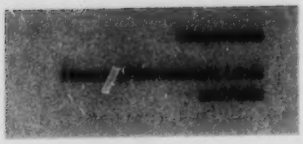
The ministry has developed a website for the BEC. It includes information about how the system works, its applications, and BEC codes, maps, projects, publications, software, staff, and related links (www.for.gov.bc.ca/research/becweb/becinfo/index.htm).

Biogeoclimatic mapping was revised this year to a larger scale in portions of the Prince George, Prince Rupert and Kamloops forest regions.

The field guide supplement to the ESSFxv2, the hardwood ecosystems of the SBSdk and ICHmc2, the updated SBSmw and site-series classifications for 15 other biogeoclimatic units, and the report on the ecology of the Mountain Hemlock (MH) zone will all help forest managers better apply provincial guidelines, at both strategic and operational levels.

Relationships between site index and ecological sites are being developed in the SIBEC (Site Index Biogeoclimatic Ecosystem Classification) project. Pictured is Torpy River (Prince Rupert Forest Region), where a variety of adjacent ecosystem types have different productivity potential.

The predictive ecosystem mapping model, EcoGen, was applied in three pilot projects (North Coast, Telkwa and Clearwater). In two of those, site-index data from the Site Index Biogeoclimatic Ecosystem Classification

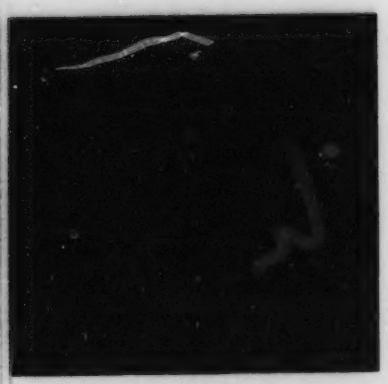


(SIBEC) project were used to evaluate potential site productivity. Timber yield analyses were conducted using this information. They showed improved mid- to long-term harvest flow for the two pilot areas because previous data had underestimated the productivity of the sites.

OLD GROWTH

Background

The policy on landscape-unit planning in B.C. recommends areal targets for the retention of old-growth forest, by designating Old Growth Management Areas. Forest Practices Code documents establish targets for forest patch sizes and for the amount of interior old forest.



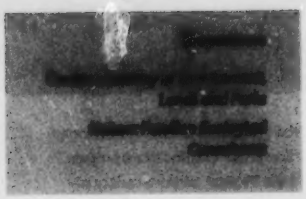
A stand of old-growth Sitka spruce, western redcedar and western hemlock in the Coastal Western Hemlock (CWH) zone.

Summary

A standard methodology and set of definitions for assessing patch sizes and the amount of interior old forest have not been available in the past. As a result, a variety of alternative approaches have been used by government and industry. To create consistency among these approaches (and with a view to improving Forest Practices Code guidebooks), researchers and a Ministry of Forests GIS (Geographic Information System) analyst in the Cariboo Forest Region have developed a standardized approach for that region. Patch-size analysis defines patches as areas of uniform seral stage (mature and old forests) or inventory age class (younger forests). The approach builds on a methodology developed by the Kamloops Forest Region Research Section, and uses the Cariboo Forest Region inventory database to identify patches, including interior forest, over the entire landscape.

In another project, researchers examined structural and functional differences between stands of different ages since disturbance in the ICHmm[1] and ESSFmm within the Robson Valley in the Prince George Forest Region. This will give resource managers more flexibility in the choice of Old Growth Management Areas based on inventory age.

Researchers also studied the MSdk in the Nelson Forest Region to determine whether old seral stands can be ranked by their structural attributes. Thirty-eight stands of MSdk were sampled, ranging in mean age from approximately 64 to 299 years. Two groups of stands—wet and dry—responded differently. The wet stands were separated further into two different groupings based on the combination of their structural attributes: one had high "old-growthness" (i.e., large or abundant structural attributes), and the other had low or no large structural attributes.



Results or products

Old Growth Management Areas are to be designated by 2003. Results of the Prince George and Nelson forest region projects provide a means to rank old-growth attributes in selected subzones. This will contribute to meeting the goal of designating areas by 2003. The research results will be especially helpful where there is disagreement between agencies or other stakeholders on the value of particular stands.

Researchers and GIS analysts in the Cariboo Forest Region have prepared patch-size maps and assessment tables for all landscape units in the region. The forest district and industry are using these products for landscape-unit planning and to review proposed harvest blocks.

COARSE WOODY DEBRIS

Background

In B.C., the management of coarse woody debris (CWD) is addressed in the Forest Practices Code. But our understanding of the quantitative role that CWD plays in forest ecosystem dynamics, and the effects of current management practices on this resource are, at present, incomplete.

Summary

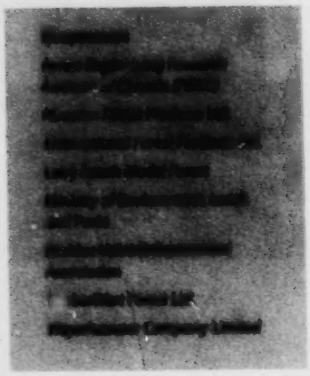
The Coarse Woody Debris Provincial Technical Working Group completed several initiatives over the past year, including:

- extensive post-harvest CWD surveys in the Kamloops, Nelson and Prince George forest regions, to provide baseline information describing the CWD resource on blocks without active CWD management,
- pre-harvest measurements on a monitoring pilot in the Prince George Forest Region to assess amounts of CWD, and
- economic assessments of a Houston Forest Products Ltd. cutblock with two levels of CWD retention is scheduled for harvesting for the summer of 2001.

The Vancouver Forest Region regional working group completed pre-harvest measurements in coastal old-seral stands. The group's objective was to determine if modified bucking and yarding practices are effective and economically feasible methods of increasing post-harvest CWD levels.

Results or products

For the Research Branch website, researchers prepared a bibliography on CWD interactions with fungi, soil organisms, nutrient cycling and vegetation dynamics.



The extensive CWD survey data revealed the range of CWD volumes that exist after harvesting, and how those volumes are partitioned by decay class, piece diameter and piece length. Researchers found no consistent relationships for the influences of season of harvest and site preparation technique, or lack thereof, on post-harvest CWD volumes.

LANDSCAPE ECOLOGY

Background

Landscape ecology research helps us understand the influence of management activities on landscape-level patterns and processes. We are then better able to comprehend how uncertainty in spatial and temporal processes at the landscape level affect forest management activities.

Cooperators

Ministry of Environment, Lands and Parks

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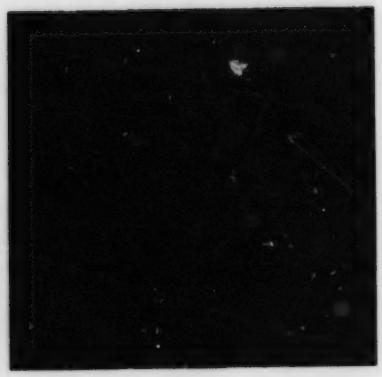

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Cooperators

Cariboo: Ministry of Environment, Lands and Parks

Nelson: Pandion Ecological Consultants

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Cooperators

Forest Engineering Research Institute of Canada (FERIC)
Houston Forest Products Ltd.
International Forest Products Ltd.
Long Beach Model Forest
Ministry of Environment, Lands and Parks
Residue Value Enhancement Association
TimberWest Forest Ltd.
Weyerhaeuser Company Limited

LANDSCAPE ECOLOGY

Background

Landscape ecology research helps us understand the influence of management activities on landscape-level patterns and processes. We are then better able to comprehend how uncertainty in spatial and temporal processes at the landscape level affect forest management activities.

There is substantial concern about the effects of natural disturbances, such as insects and fire, on timber supply. There is also a concern that planning for sustainable timber supply does not address issues concerning sustainability of other values, such as wildlife habitat. Tools are needed to address these issues in strategic plans. Additionally, at smaller spatial scales, ecosystem management has created new challenges for forest managers. To meet these challenges, managers need methods to characterize natural ecological patterns. They also need ways to predict and evaluate the effects of ecological processes (e.g., wildfire, insects and succession) and management processes. To facilitate complex landscape analysis, rigorous data management techniques are necessary.

Summary

In projects throughout the province, researchers are investigating how to better project the relationships among timber supply, habitat supply, and natural disturbances at very large spatial scales by developing models of the current forest management regime and ecological processes. The models are stochastic (i.e., they include a random variable), so they may include variability in frequency, location, size of harvesting blocks and insect outbreaks, and the timing and consequences of succession. For example, a project in the Robson Valley Forest District (Prince George Forest Region) examined the effect of western hemlock loopers on unsalvaged losses to timber supply. This project is studying more realistic ways of including natural disturbances in timber supply modelling. Similar projects in the Columbia Mountains and Kispiox Forest District (Prince Rupert Forest Region) have examined the effect of forest harvesting on the supply of habitat for sensitive species.

Ecological processes occur at a variety of scales, so a hierarchical approach to managing forested landscapes is needed—one that can provide both detailed and summary information, as required. To facilitate analysis and community involvement, researchers have developed a framework and a set of tools to bring together stakeholders, ecologists and modellers to address a variety of research and operational questions.

Cooperators

Ministry of Environment, Lands and Parks

Parks Canada

Simon Fraser University

Results or products

One of the primary assumptions in typical timber supply analyses is that natural disturbances are constant in time and space. But researchers examining non-recoverable losses from natural disturbances in the Robson Valley found that these disturbances create losses that are unpredictable in time and space, and often unsalvageable. For this project, researchers developed a spatial model for forest dynamics to assess the vulnerability of timber supply to non-recoverable losses. It is an alternative, process-based model that resulted in more intuitively reasonable behaviour of natural disturbances, so it is more likely to generate ecologically reasonable results. In particular, the model preserves the key features of the disturbances, such as area affected and disturbance return periods, and it has the disturbances respond to changes in the forest composition across the landscape (e.g., hemlock loopers continue to attack old hemlock stands). This modelling approach predicts current unsalvageable losses that are similar to the current values used in the Timber Supply Review, but it predicts that future losses will be lower than those of review estimates.

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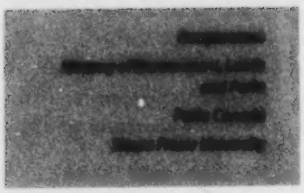

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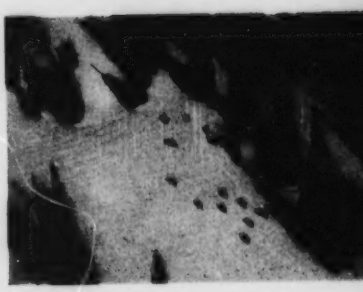
A key result of the Natural Disturbance and Landscape Planning Project was the development of complex landscape analysis techniques for characterizing landscapes and identifying ecological patterns for operational planning. These techniques have been applied in the Invermere Forest District in the Nelson Forest Region. In the Prince Rupert Forest Region, they have been applied in the Lakes, Morice and Bulkley/Cassiar forest districts, and in habitat analysis in the Kispiox and North Coast forest districts. Using the techniques, researchers applied landscape models within a collaborative modelling framework to analyze mountain pine beetle control scenarios in the Lakes Forest District, the interaction of fire and timber supply in the Invermere Enhanced Forest Management Pilot Project, and fire and resource management zonation in the Iskut-Stikine Land and Resource Management Plan. Researchers also developed techniques for improved geospatial data management, which helped accelerate the implementation of a multi-agency, northwestern B.C. data warehouse. Lastly, researchers explored using the Internet as a way of distributing landscape analysis tools and methods.

In a different project (Habitat, Timber Supply and Natural Disturbance: Integration Using Landscape Simulation), researchers developed methods to manage and disseminate spatial data through data warehousing, using the Columbia Forest District (Nelson Forest Region) and the Prince Rupert Forest Region as operational sites. In another key result, researchers developed habitat suitability models for use in landscape modelling in the Columbia Mountains, and for caribou and grizzly bears in the Kispiox Forest District. Finally, researchers developed a landscape model to balance the needs for caribou habitat and timber supply in the Columbia Mountains.



In the Prince George Forest Region, researchers are conducting population inventories of threatened woodland caribou in the central interior to determine the distribution and abundance of different herds.

WILDLIFE

Background

Wildlife research is currently focusing on species that are sensitive to human activities, are found over a significant portion of the province, and have a high international profile. Grizzly bears, for example, are among the most high-profile and sensitive species of large mammals in the province, and their conservation is a major objective of most land-use plans. Similarly, the integration of mountain caribou into forest management over much of the interior wetbelt forests is a significant land-use issue. Efforts are being made to distinguish early- and late-winter caribou distribution. The development of silvicultural systems that accommodate both timber harvesting and the maintenance of habitat for caribou and grizzly bears has been a priority of current research.

Pine mushroom (*Tricholoma magnivelare*) in the Nass Valley (Prince Rupert Forest Region).

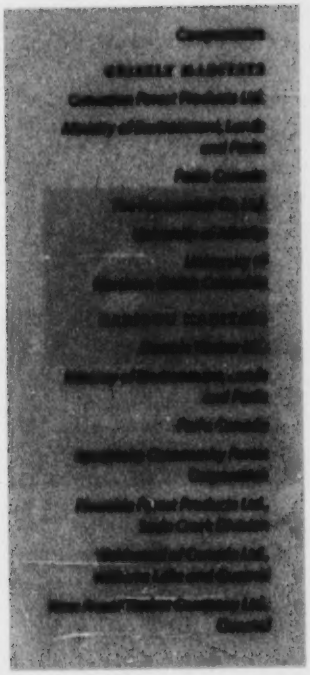
Summary

A five-year Forest Renewal BC project involved monitoring radio-collared grizzly bears in two study areas in the Nelson Forest Region. In the course of that project, researchers have developed generic cumulative effects models to show, over a range of spatial and temporal scales, how a variety of human activities affect grizzly bear habitat use and quality.

North of Prince George, researchers gather information about grizzly bear populations by collecting hair from barbed wire surrounding baited sampling sites. Individual grizzlies are identified from DNA analysis of the hair samples.

In another project, researchers monitored radio-collared grizzlies in the Prince George and Dawson Creek forest districts (Prince George Forest Region) and the Cranbrook Forest District (Nelson Forest Region) to determine movements, home ranges, and habitat selection. Researchers visited sites used by grizzlies to determine habitat characteristics and feeding activity. To inventory and count the bears, researchers in the Prince George study area employed a method developed by ministry grizzly bear researchers in the Nelson Forest Region. The method, which is used worldwide, involves the non-intrusive collection of a hair sample for DNA testing.

Other researchers continued developing and testing silvicultural systems to maintain mountain and northern caribou within a managed forest environment. These long-term projects were initiated in 1990 for mountain caribou and in 1994 for northern caribou. The research has become even more timely with the release of the Cariboo-Chilcotin Land-Use Plan, which lists the maintenance of caribou as a key objective.



Also in 2000/01, researchers summarized the results of the habitat availability study for mountain caribou in the Columbia Mountains. Recommendations have been made to incorporate caribou habitat requirements into timber supply models, and to test habitat-sparing partial-cutting methods in the Interior Cedar–Hemlock (ICH) zone for operational feasibility.

Results or products

Resource managers have used studies of grizzly bear habitat use to develop landscape-unit objectives and stand management recommendations to maintain habitat. Models of grizzly bear habitat use developed from this research have been incorporated into a forest harvesting model. (For reports and journal articles on grizzly bear habitat published by ministry researchers during 2000/01, see the publications list, page 43.)

Silvicultural systems for areas of mountain and northern caribou habitat will be applied over hundreds of thousands of hectares within the Cariboo Forest Region. These areas are designated as "modified harvest" for caribou in the Cariboo-Chilcotin Land-Use Plan. Results of these long-term projects on silvicultural systems and caribou habitat on the Chilcotin Plateau have been published in two working

papers. The results also contributed to the Cariboo-Chilcotin Land-Use Plan Mountain Caribou Strategy, which was released in October 2000.

Results from the habitat availability study (and other related projects) will help resource managers make informed decisions about forest management that maintains caribou. A number of articles and reports recording the results of caribou habitat study in the Columbia Mountains have been completed (see the publications list, page 43).

RANGE ECOSYSTEMS

Background

Range research helps the ministry meet its range management obligations to conserve grassland and open forest ecosystems, produce forage for domestic livestock and wildlife, and manage livestock grazing tenures.

Summary

The regional land-use planning process (specifically, for the Kootenay-Boundary Land-Use Plan) recognized the altered fire regime within natural disturbance type 4 (NDT4) forests and its effect on natural resource values. That led to the creation of the Ecosystem Restoration Program. In an adaptive management project, researchers are monitoring understorey vegetation changes and residual stand structure following thinning and/or burning of ingrown fire-maintained forests.

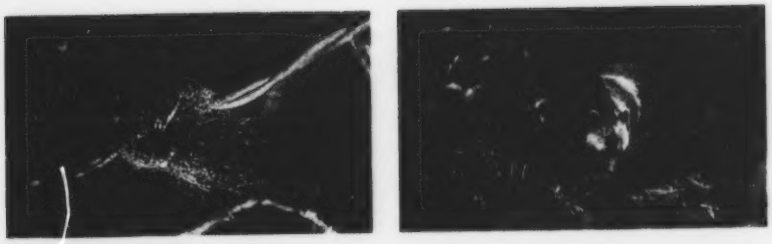
In another adaptive management project, researchers are examining alternative livestock management in areas associated with lakes and ponds. The project is designed to help resource managers maintain or restore the natural function of the riparian areas in grassland communities, as required by the Forest Practices Code.

Forest encroachment has substantially reduced livestock and wildlife forage, and it is a significant threat to important grassland habitat for plant and animal species in the Cariboo-Chilcotin region. To encourage better management of grassland areas, the Cariboo-Chilcotin Land-Use Plan established livestock grazing targets and goals for conserving grassland species and ecosystems. Areas designated in the Cariboo-Chilcotin region have been mapped for long-term management as grasslands rather than forest. Resource managers have identified forest encroachment within this area. In response, they have set grassland restoration priorities and broad tree-cover objectives. Researchers are collecting tree density, tree growth, and vegetation data from ingrown stands that were historically open and adjacent to the grasslands, to help them relate stand structure to tree growth and vegetation development.

Results or products

During 2000/01, researchers completed a workshop and scientific publications extending the results of a long-term project studying the effects of cattle trampling and browsing on lodgepole pine (see the publications list, page 43).

Cooperators
Agriculture and Agri-Food Canada
University of British Columbia



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Cooperators

GRIZZLY HABITATS

Canadian Forest Products Ltd.

Ministry of Environment, Lands and Parks

Parks Canada

The Pas Lumber Co. Ltd.

University of Alberta

University of Northern British Columbia

CARIBOU HABITATS

Downie Timber Ltd.

Ministry of Environment, Lands and Parks

Parks Canada

Revelstoke Community Forest Corporation

Riverside Forest Products Ltd., Soda Creek Division

Weldwood of Canada Ltd., Williams Lake and Quesnel

West Fraser Timber Company Ltd., Quesnel

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Cooperators
Agriculture and Agri-Food Canada
University of British Columbia

Researchers have produced a number of scientific publications and annual reports and held extension activities on their work in integrating forest and range activities, and the sustainable use of riparian and dry-forest ecosystems. Forest districts continue to use these products to meet ministry range management obligations.

Areas designated as managed grassland in the Cariboo-Chilcotin now can be included in landscape-unit plans. Tree-cover objectives for the designated areas will guide the development of silviculture prescriptions, and the tree-growth and vegetation information provided by researchers will help resource managers develop stand structure targets for ingrown stands.

NON-TIMBER FOREST PRODUCTS

Background

Non-timber forest products (NTFPs) have current and potential roles to play in sustainable forest management. Through studies involving NTFPs, researchers and resource managers are better able to understand the influence of management activities on the full spectrum of forest botanical and fungal resources. Since very little information exists on their habitat requirements and responses to disturbance, research efforts are aimed at gathering ecological and management data needed to help sustain the NTFP industries within a strong and sustainable timber harvesting sector.

Summary

Current NTFP research consists of approximately six inter-disciplinary projects located throughout B.C.'s forest regions. Some of the specific NTFP issues that are being addressed are the habitat description and mapping of pine mushroom (*Tricholoma magnivelare*), the response of culturally important plants to fire, site attributes for a number of commercial plant and fungal species, and the effects of forest management on NTFP production.

Cooperators

Inner Coast Natural Resource Centre
Ktunaxa-Kinbasket Treaty Office
'Namgis First Nation
Royal Roads University
University of British Columbia
University of Victoria

Results or products

During 2000/01, researchers in the regions and branches produced a variety of publications on the ecology and response of some NTFPs to forest management activities (see the publications list, page 43).

Earth Sciences

WATERSHED MANAGEMENT

At Gray Creek near Sechelt (Vancouver Forest Region), a weir is used to monitor long-term streamflow.

Background

Developing appropriate watershed management practices requires an understanding of the various parts of the hydrological cycle, how hydrology interacts with other watershed processes, and how forestry activities change these processes. Watershed research helps clarify how excess water is generated in forest stands, how water flows over and through the soil, where sediment is generated in the landscape, how sediment enters stream channels and other aquatic systems, and where it may affect water quality and fish habitat.

Researchers have produced a number of scientific publications and annual reports and held extension activities on their work in integrating forest and range activities, and the sustainable use of riparian and dry-forest ecosystems. Forest districts continue to use these products to meet ministry range management obligations.

Areas designated as managed grassland in the Cariboo-Chilcotin now can be included in landscape-unit plans. Tree-cover objectives for the designated areas will guide the development of silviculture prescriptions, and the tree-growth and vegetation information provided by researchers will help resource managers develop stand structure targets for ingrown stands.

NON-TIMBER FOREST PRODUCTS

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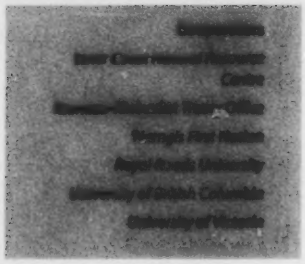

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At Gray Creek near Sechelt (Vancouver Forest Region), a weir is used to monitor long-term streamflow.

This knowledge is used to plan sound forest development at the site, drainage-basin, and landscape levels, both to ensure sufficient forest retention on sensitive sites, and to help forest planners design better forest road networks. Understanding these processes also helps planners focus watershed restoration work on the areas and the individual watersheds where it will be effective and have the greatest benefits.

Summary

In 2000, ministry researchers led a joint agency collaborative project to identify and characterize forestry practices that are used adjacent to small, potentially fish-bearing streams in two interior forest regions. Teams visited S4 streams (as classified under the Forest Practices Code) in cutblocks in six interior forest districts, where they made observations on the condition of stream channels and adjacent riparian management areas. Contrary to concerns that logging was destroying most small stream channels, the results indicated that forest practices carried out under full code provisions were maintaining stream channel and fish habitat integrity.

Not all of the precipitation falling on a watershed reaches the ground. In mature forests, 20% to 30% of the precipitation remains on the leaves or branches, or is absorbed by material in the canopy. From there, it evaporates back into the atmosphere.

In another multi-disciplinary project funded by Forest Renewal BC in the Prince George Forest Region, researchers began investigating the ecological effectiveness of the Prince George Forest District's policy for maintaining healthy fish habitat in S4 streams. The project will investigate the dominant watershed processes in small streams. It will also use adaptive management principles to refine the policy that addresses sustainable forest management and the maintenance of environmental values and resource benefits.

In the Cariboo Forest Region, researchers are studying the effects of the group selection silviculture system on snow accumulation and melt in the Quesnel Highlands. Researchers are looking at harvesting alternatives in high-elevation forests, and, correlating five years of snow data collected from a research site near Quesnel, they are developing a new method to measure canopy density.

At Mayson Lake in the Kamloops Forest Region, researchers investigated the effects of treatments in several typical interior forest-cover types on snow accumulation and melt. The study included a clearcut area, a mature spruce-fir forest, and two juvenile lodgepole pine stands (one thinned and one unmanaged stand).

In the Vancouver Forest Region, researchers are analyzing the initial effects of partial logging on peak streamflow at Flume Creek in the Roberts Creek Study Forest. The results after two years showed that peak flow increased as canopy removal increased.

Cooperators

LANDSLIDE PREDICTION STUDY IN THE COAST MOUNTAINS

Forest Renewal BC

Geowise

Golder Associates

Ministry of Environment, Lands and Parks

Weyerhaeuser Company Limited

FAN PROJECT

Fisheries and Oceans Canada

Ministry of Environment, Lands and Parks

National University of Singapore

Silvicon Services Inc., Smithers

Simon Fraser University, Earth Sciences

Skeena Cellulose, Inc.

University of British Columbia, Department of Geography

University of British Columbia, Faculty of Forestry

West Fraser Timber Company Ltd.

NORTH COAST PROJECT

B and I Forest Products

Forest Renewal BC

Lax Kw'alaams Development Corp.

University of British Columbia

University of Waterloo

Western Forest Products Ltd.

RIPARIAN PROJECT

Canadian Forest Products Ltd.

Dunkley Lumber Ltd.

Fisheries and Oceans Canada

Forest Renewal BC

Pierre Beaudry and Associates

The Pas Lumber Co. Ltd.

STREAM SHADE

Forest Renewal BC

Riverside Forest Products Ltd.

MAYSON LAKE SNOW ACCUMULATION STUDY

Forest Renewal BC

Weyerhaeuser Company Limited

QUESNEL LAKE PROJECTS

Forest Renewal BC

Weldwood of Canada Ltd.

West Fraser Timber Company Ltd.

To assess the likelihood of landslides, researchers studied landslide rates and locations for specific terrain types in the Coast Mountains. The study showed that landslide rates in the coastal mountain ranges are much lower than they are in several other areas in the Vancouver Forest Region, particularly on the Queen Charlotte Islands.

Researchers studying sediment budgets at the Tsitika River in the Vancouver Forest Region have found that the main factors controlling sediment production are lithology (i.e., the physical characteristics of rock) and the location of sediment sources near the channel network. Researchers developed a sediment budget model for fine sediment at Russell Creek, based on sediment production from gullies, landslide scars and road crossings.

Researchers initiated a study to develop appropriate prescriptions and hazard classification for forestry on fans in the Prince Rupert Forest Region. This project will also help expand the current riparian guidelines on how to recognize hydrogeomorphic processes (i.e., debris flows and floods). Researchers described 16 unlogged and 14 logged fans and the watersheds using helicopter reconnaissance and GIS (Geographic Information System). Discussions were held with forest licensees to document practices on the logged fans. These discussions and the field evaluations will be used to develop a compendium of best management practices for fans.

Results or products

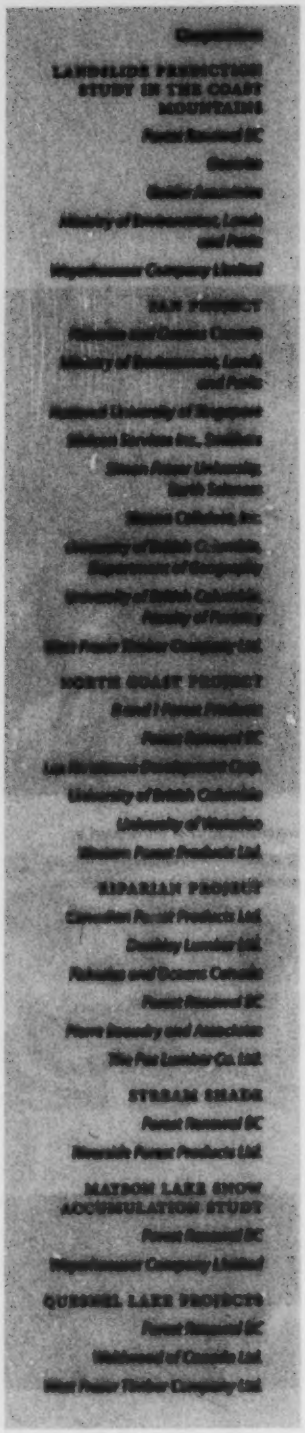
Results have been used in several workshops on a new policy, initiated by the Prince George Forest District, to manage riparian areas near small (S4) fish-bearing streams. From a study in the Vancouver Forest Region of woody debris in S5 and S6 streams, the ministry developed an assessment procedure that can be used to predict whether slash (i.e., woody debris) will be transported in a stream. The ministry has incorporated this assessment method into the Gully Assessment Procedure.

Hydrology researchers in the Vancouver Forest Region are improving methods for measuring how quickly regenerating forests restore site hydrology to near pre-harvest conditions. The research has already demonstrated that recovery is faster than was previously thought. In the Cariboo Forest Region, researchers published an extension note describing a new instrument for measuring stream shade. Results of the Mayson Lake snow accumulation study in the Kamloops Forest Region have been summarized in the proceedings of a watershed assessment conference, a journal publication, and an operational extension note. In a collaborative effort, researchers from the Research Branch and the Nelson and Kamloops forest regions produced proceedings of a Penticton workshop on watershed assessment in the southern interior. (See the publications list, page 43.)

SOIL CONSERVATION

Background

The primary goal of Ministry of Forests soil science research and extension is to help maintain soil productivity by providing cost-effective management tools and information. This work supports key ministry priorities related to the Forest



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Practices Code, the costs of harvesting, the allowable annual cut, soil conservation and rehabilitation, and the demonstration of sustainable forest management.

Timber harvesting, road-building, site preparation and other forest management activities affect the physical, chemical and biological properties of soil. Soil disturbance (e.g., from erosion or compaction) can have positive, negative, or neutral effects on site productivity and off-site values. Researchers, working with operational ministry staff and industry, have developed strategies to help maintain site productivity and conserve soils during forest management activities.

One of the many studies being conducted by ministry soil scientists is the Long-Term Soil Productivity Study. This study was designed on a rotation-length time frame, so it will give researchers the extended perspective they need to understand long-term soil processes and the effects of management activities. Those include the effects on site productivity of soil compaction and the loss of organic matter (see page 14 in the feature article).

Top Shallow disturbance of calcareous subsoil at Mud Creek (Nelson Forest Region). Also shown are microclimate monitoring equipment and seedlings netted to protect them from wildlife browsing.

Bottom At Perry Creek (Nelson Forest Region), coarse platey soil structure indicates soil compaction. That often results in reduced aeration porosity, which can restrict root function and tree growth.

Summary

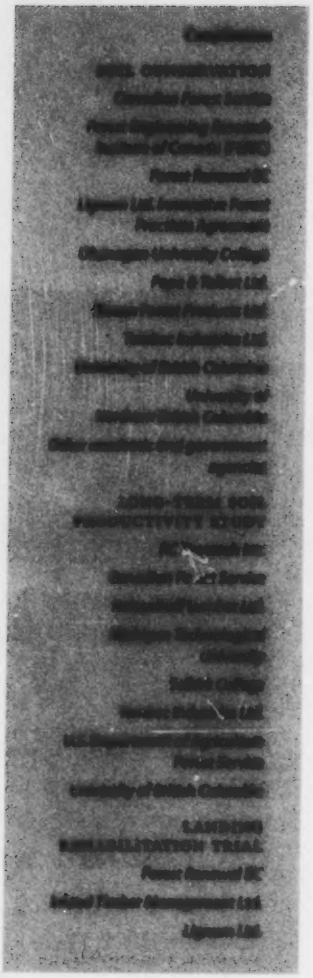
During 2000/01, soil scientists continued work on a network of research and demonstration sites throughout B.C., extrapolating the results to a broad range of soil conditions. Study topics included soil rehabilitation, the effects of silvicultural systems and root removal on soil productivity, nitrogen fixation and cycling, the effects of prescribed burning on soil and forest productivity, the role of ectomycorrhizal mushrooms and mycorrhizal associations in the performance of crop trees, and the effects of bole removal on soil communities and the consequences for long-term productivity and soil quality.

Highlights included the involvement of the U.S. Department of Agriculture (USDA) Forest Service and Michigan Technical University in a field tour of forest management on calcareous (i.e., high pH) soils and studies on wood decomposition and site productivity. Five-year results for the sub-boreal spruce sites were reported at the Long-Term Soil Productivity 2000 10-year conference in Louisiana. Through collaborative work with the USDA Forest Service in Idaho and Selkirk College in Castlegar, researchers developed a new Long-Term Soil Productivity Study initiative in the Interior Cedar–Hemlock (ICH) zone: fertilizers and biosolids will be used experimentally to see if they enhance productivity in an ecologically sustainable manner.

Results or products

This year, researchers published the final *Silviculture Prescription Data Collection Field Handbook, Land Management Handbook No. 47*, which standardizes data collection for planning resource management activities. The data collection protocols were designed for use with the existing field data collection forms FS39a and FS39b.

Researchers also published a provincial forest and range soils research and extension strategy (see the publications list, page 43). It will help guide investments in soils research and coordinate the efforts of the soil research community.



Researchers helped deliver seven soil rehabilitation field-based training sessions in the Kamloops Forest Region during 2000/01, to some 200 participants.

A report was completed in the Cariboo Forest Region on a cooperative trial with Lignum Ltd. near Williams Lake to bring landings back into tree production. With Forest Renewal BC funding, researchers applied a variety of cultivation, fertilization, and mixed-species planting treatments to approximately 650 landings from 1996 to 1998. The team also developed preventive measures, where necessary, to reduce cattle damage. Treatment costs ranged from less than $200 to more than $2000 per landing. The 2000/01 report indicates good initial success with landing rehabilitation across a wide range of conditions and treatments.

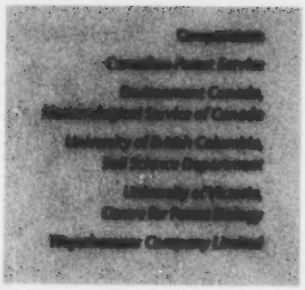
CLIMATOLOGY

Background

Increasing concentrations of greenhouse gases in the atmosphere may cause changes in climate, which may, in turn, alter the future sustainable use of natural resources. The B.C. government is party to national and international accords to help control and reduce greenhouse gas emissions. In response to these accords, we are determining how forest management affects the amount of carbon dioxide in the atmosphere, and how future climate change could affect forest management. Forest management can affect water flow and water quality in watersheds. Understanding basic hydrologic processes and the effects of climate and changing forest cover on these processes provides a basis for evaluating the effectiveness of forest practices in maintaining watershed processes.

Summary

A preliminary analysis was made of B.C.'s forest carbon balance. In cooperation with the Canadian Forest Service, researchers used a computer model to illustrate, under various forest management regimes, whether B.C.'s forests are a carbon sink or a carbon source. Researchers found that greater detail is required in defining forest ecosystems in the model. The work also showed that there is a need for improved information on the growth of managed stands, forest disturbance, coarse woody debris, and soil carbon. Researchers are conducting field studies of the forest carbon balance. With those data, they will be able to test the forest carbon balance model. Researchers are also contributing to work on procedures and mechanisms to include forests in international carbon-trading initiatives.



The Upper Penticton Creek Watershed Experiment is one of a small number of projects in which researchers are evaluating the effects of forest management on aquatic habitat, water quality, and steam flow. Climatology researchers have participated in this work by monitoring site weather conditions (and their influence on snow accumulation and melt) and the forest water balance.

Results or products

During 2000/01, researchers contributed to the development of a business plan to improve and guide the assessment of B.C.'s forest carbon balance.

Information from the Forest Science Program's preliminary carbon balance analysis was used to help develop a provincial/federal Canadian strategy about how forests should be considered in negotiations on the Kyoto Protocol to control greenhouse gases.

Researchers assessed the potential effects of climate change over the next 50 years on B.C.'s forest ecosystems. Changes in the rates of forest disturbance by fire and insects are likely to be one of the biggest challenges facing forest management.

As part of the Upper Penticton Creek Watershed Experiment this year, researchers made measurements to assess the effect of forest cover on water flow to streams. They also evaluated snow melt and forest water balance models, and produced a report on the past five years of the study. (See the publications list, page 43.)

Near Campbell River on Vancouver Island (Vancouver Forest Region), sensors and a sampling port for CO_2 and water vapour flux measurements are used to determine the net carbon balance above a 55-year-old Douglas-fir stand.

KARST

Background

Karst ecosystems are unique. They contain distinctive surface features, caves, and subsurface drainage systems that allow water to flow quickly from one area to another. Karst terrain also provides unique microclimates and habitats for uncommon plants and animals. Karst ecosystems are often highly productive for growing trees, but they can also be sensitive to disturbance, and may require modified management practices to protect and maintain their unique characteristics. Many of the karst areas in B.C. are globally significant.

Summary

B.C. karst inventory standards and procedures have been completed and approved by the provincial Resource Inventory Committee. Forest Science Program researchers contributed in several important ways. They initiated the development of an interpretive algorithm for identifying potential karst units using existing 1:250 000 bedrock geology maps. They also coordinated the development of procedures for conducting planning-level inventories and karst field assessments, and for evaluating the vulnerability of a karst unit to surface disturbance.

Results or products

The karst inventory standards and procedures were developed to identify karst landscapes and categorize them into areas of similar vulnerability. This work will allow resource managers to develop appropriate site-specific management regimes.

Karst management guidelines are being developed to take advantage of the new karst inventory and vulnerability assessment procedures, which will be closely linked to the inventory standards.

Cooperators

Canadian Forest Products Ltd., Englewood Logging Division

Doman-Western Lumber Ltd., Nukko Region, Gold River

Cooperators

SOIL CONSERVATION

Canadian Forest Service

Forest Engineering Research Institute of Canada (FERIC)

Forest Renewal BC

Lignum Ltd. Innovative Forest Practices Agreement

Okanagan University College

Pope & Talbot Ltd.

Slocan Forest Products Ltd.

Tembec Industries Ltd.

University of British Columbia

University of Northern British Columbia

Other academic and government agencies

LONG-TERM SOIL PRODUCTIVITY STUDY

BC Research Inc.

Canadian Forest Service

Kalesnikoff Lumber Ltd.

Michigan Technological University

Selkirk College

Tembec Industries Ltd.

U.S. Department of Agriculture Forest Service

University of British Columbia

LANDING REHABILITATION TRIAL

Forest Renewal BC

Inland Timber Management Ltd.

Lignum Ltd.

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Canadian Forest Service

Environment Canada, Meteorological Service of Canada

University of British Columbia, Soil Science Department

University of Victoria, Centre for Forest Biology

Weyerhaeuser Company Limited

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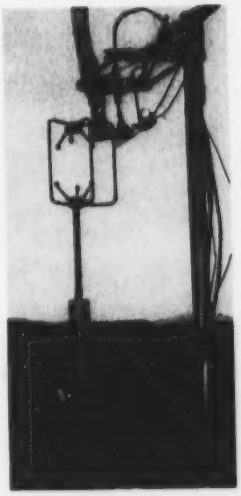

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Karst management guidelines are being developed to take advantage of the new karst inventory and vulnerability assessment procedures, which will be closely linked to the inventory standards.

Cooperators

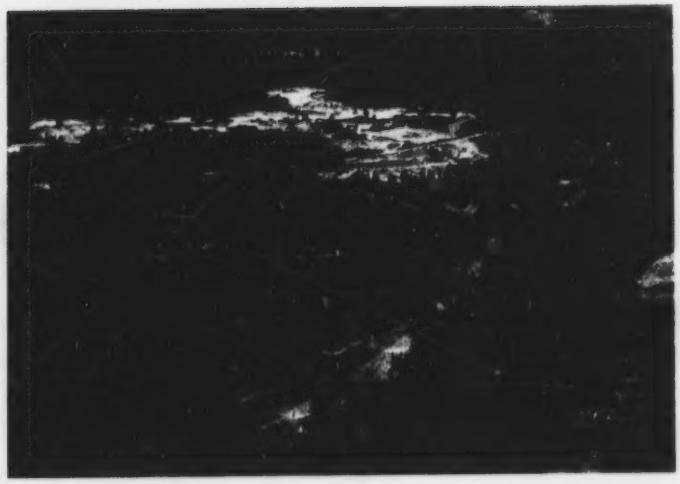
Canadian Forest Products Ltd., Englewood Logging Division

Doman-Western Lumber Ltd., Nutka Region, Gold River

ENHANCING SEED PRODUCTION IN LODGEPOLE PINE SEED ORCHARDS

Background

Seed set in north-Okanagan lodgepole pine seed orchards has not reached expected levels during the past few years. The low seed set has been a major impediment for seed orchards to reach their production goals. Seed yields must be increased to attain the British Columbia Forest Genetics Council goal of increasing production capacity by 65% to 70% and doubling genetic gain by 2007.



An overhead mist irrigation system cools tree crowns when the temperature exceeds 24 degrees Celsius.

Summary

In two north-Okanagan seed orchards, researchers are testing improved cultural techniques. In each orchard, they established experimental plots to test improved irrigation and crown cooling to counter the effects of very hot temperatures and low humidity during sensitive stages of reproductive development. The researchers made measurements of the effects of treatments on first- and second-year seed cone survival, cone size, and second-year total seeds per cone, as well as filled seeds per cone. They used pollen monitors to determine ambient orchard pollen levels and the synchrony between orchard pollen shed and seed cone receptivity. They also collected meteorological data to determine the effects of high temperature and low humidity on cone development and seed set.

Cooperators

Forest Renewal BC

Pacific Regeneration Technologies, Grandview Bench Seed Orchard, Armstrong

Results or products

Results of the treatments were variable. However, they strongly suggest that lodgepole pine seed yield could be improved through changes in orchard management. Achieving acceptable levels will require better control over losses caused by insects, better irrigation (i.e., more water applied over a larger area), and misting to cool tree crowns when temperature and humidity levels are extreme.

WESTERN REDCEDAR INBREEDING STUDIES

Background

Western redcedar is a shade-tolerant species that is an important component of coastal forest ecosystems. Replanting seedlings is an integral part of reforestation for this species, and abundant cone crops are consistently produced in both wild stands and seed orchards. Seedlots, however, can have a self-pollination (i.e., selfing) rate anywhere from 30% to 100%, which goes undetected until seedlings are outplanted. Over a rotation, this can result in as much as a 20% loss in stand volume.

Summary

A multi-disciplinary approach has been employed to study inbreeding and its negative effect on western redcedar. Contract researchers and seed orchard managers have been examining the effects of stand management and orchard practice on self-

ing, and its effects on seed yield, viability and germination. University of British Columbia scientists have been studying the mating system of both natural and seed orchard populations. Researchers at CellFor and the University of Victoria have been investigating the physiological basis for growth reduction caused by inbreeding depression. Ministry of Forests researchers have established long-term field trials to study the effects of inbreeding on survival, volume production, and flowering.

Cooperators

Applied Forest Science Ltd.
CellFor
Hak Consulting
TimberWest Forest Ltd.
University of British Columbia
University of Victoria
Western Forest Products Ltd.
Yellow Point Propagation

Results or products

As researchers begin to understand the mating system of western redcedar, the genetic and physiological basis of inbreeding depression, and the long-term growth implications, sound management decisions can be made on how to improve seedlot vigour and subsequent stand health and volume. Seed orchard management practices—including supplemental mass pollination, crown stratification, and orchard design—are already being deployed to reduce selfing. Guidelines for reducing selfing in wild stands are currently being developed and will also help increase seedlot vigour.

PONDEROSA PINE

Background

Sustainable use of forest ecosystems relies on successful regeneration using appropriate, well-adapted tree species. Regeneration failures in the Ponderosa Pine (PP) zone and in drier portions of the Interior Douglas-Fir (IDF) zone have resulted in increased planting (to approximately 1 million annually) of ponderosa pine, B.C.'s most drought-tolerant conifer species. However, researchers know little about the biology of seed transfer or its ecological limits—information that field foresters need to manage the species.

At the Kalamalka Forestry Centre in Vernon (Kamloops Forest Region), selective breeding of interior lodgepole pine has produced improved seeds. At rotation age, trees grown from these seeds are expected to have achieved estimated volume gains of between 9% and 16%.

Summary

Seventy-three seed sources of ponderosa pine (31 in B.C. and 42 in the U.S.) were grown and planted on two ecologically contrasting sites in 1993. One was mesic (at the Skimikin Seed Orchard site near Salmon Arm) and one very dry (at Pacific Regeneration Technologies' Grandview Bench Seed Orchard, near Armstrong).

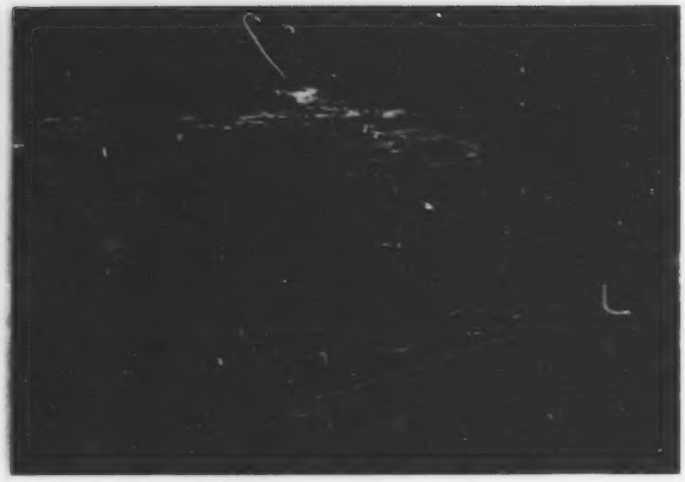
Annual tree height and stem caliper measurements have been taken for eight of the nine field seasons since planting. Seed source differentiation for total tree heights was moderate, with the best sources averaging approximately 20% greater total heights than the poorest sources. Stem volume averages differed by nearly 40% from best to poorest. With a few exceptions, the tallest trees also had the largest average stem volumes.

Based on eighth-year stem volumes, a selection index (diameter squared times height) approach was developed to thin both plantations to approximately the top 20% of test trees. The Skimikin plantation was thinned in 2000, so cone and seed production should begin there in five to eight years. Seed production is expected to be somewhat later in the slower-growing Grandview Bench site.

ENHANCING SEED PRODUCTION IN LODGEPOLE PINE SEED ORCHARDS

Background

Seed set in north-Okanagan lodgepole pine seed orchards has not reached expected levels during the past few years. The low seed set has been a major impediment for seed orchards to reach their production goals. Seed yields must be increased to attain the British Columbia Forest Genetics Council goal of increasing production capacity by 65% to 70% and doubling genetic gain by 2007.



An overhead mist irrigation system cools tree crowns when the temperature exceeds 24 degrees Celsius.

Summary

In two north-Okanagan seed orchards, researchers are testing improved cultural techniques. In each orchard, they established experimental plots to test improved irrigation and crown cooling to counter the effects of very hot temperatures and low humidity during sensitive stages of reproductive development. The researchers made measurements of the effects of treatments on first- and second-year seed cone survival, cone size, and second-year total seeds per cone, as well as filled seeds per cone. They used pollen monitors to determine ambient orchard pollen levels and the synchrony between orchard pollen shed and seed cone receptivity. They also collected meteorological data to determine the effects of high temperature and low humidity on cone development and seed set.

Cooperators

Forest Renewal BC

Pacific Regeneration Technologies, Grandview Bench Seed Orchard, Armstrong

Results or products

Results of the treatments were variable. However, they strongly suggest that lodgepole pine seed yield could be improved through changes in orchard management. Achieving acceptable levels will require better control over losses caused by insects, better irrigation (i.e., more water applied over a larger area), and misting to cool tree crowns when temperature and humidity levels are extreme.

WESTERN REDCEDAR INBREEDING STUDIES

Background

Western redcedar is a shade-tolerant species that is an important component of coastal forest ecosystems. Replanting seedlings is an integral part of reforestation for this species, and abundant cone crops are consistently produced in both wild stands and seed orchards. Seedlots, however, can have a self-pollination (i.e., selfing) rate anywhere from 30% to 100%, which goes undetected until seedlings are outplanted. Over a rotation, this can result in as much as a 20% loss in stand volume.

Summary

A multi-disciplinary approach has been employed to study inbreeding and its negative effect on western redcedar. Contract researchers and seed orchard managers have been examining the effects of stand management and orchard practice on self-

ing, and its effects on seed yield, viability and germination. University of British Columbia scientists have been studying the mating system of both natural and seed orchard populations. Researchers at CellFor and the University of Victoria have been investigating the physiological basis for growth reduction caused by inbreeding depression. Ministry of Forests researchers have established long-term field trials to study the effects of inbreeding on survival, volume production, and flowering.

Cooperators
Applied Forest Science Ltd.
CellFor
Hak Consulting
TimberWest Forest Ltd.
University of British Columbia
University of Victoria
Western Forest Products Ltd.
Yellow Point Propagation

Results or products
As researchers begin to understand the mating system of western redcedar, the genetic and physiological basis of inbreeding depression, and the long-term growth implications, sound management decisions can be made on how to improve seedlot vigour and subsequent stand health and volume. Seed orchard management practices—including supplemental mass pollination, crown stratification, and orchard design—are already being deployed to reduce selfing. Guidelines for reducing selfing in wild stands are currently being developed and will also help increase seedlot vigour.

PONDEROSA PINE

Background
Sustainable use of forest ecosystems relies on successful regeneration using appropriate, well-adapted tree species. Regeneration failures in the Ponderosa Pine (PP) zone and in drier portions of the Interior Douglas-Fir (IDF) zone have resulted in increased planting (to approximately 1 million annually) of ponderosa pine, B.C.'s most drought-tolerant conifer species. However, researchers know little about the biology of seed transfer or its ecological limits—information that field foresters need to manage the species.

At the Kalamalka Forestry Centre in Vernon (Kamloops Forest Region), selective breeding of interior lodgepole pine has produced improved seeds. At rotation age, trees grown from these seeds are expected to have achieved estimated volume gains of between 9% and 16%.

Summary
Seventy-three seed sources of ponderosa pine (31 in B.C. and 42 in the U.S.) were grown and planted on two ecologically contrasting sites in 1993. One was mesic (at the Skimikin Seed Orchard site near Salmon Arm) and one very dry (at Pacific Regeneration Technologies' Grandview Bench Seed Orchard, near Armstrong).

Annual tree height and stem caliper measurements have been taken for eight of the nine field seasons since planting. Seed source differentiation for total tree heights was moderate, with the best sources averaging approximately 20% greater total heights than the poorest sources. Stem volume averages differed by nearly 40% from best to poorest. With a few exceptions, the tallest trees also had the largest average stem volumes.

Based on eighth-year stem volumes, a selection index (diameter squared times height) approach was developed to thin both plantations to approximately the top 20% of test trees. The Skimikin plantation was thinned in 2000, so cone and seed production should begin there in five to eight years. Seed production is expected to be somewhat later in the slower-growing Grandview Bench site.

Cooperators

Pacific Regeneration Technologies, Grandview Bench Seed Orchard, Armstrong

Comparative analyses of the growth and survival data on the two ecologically contrasting sites will be completed in the near future. This information on the growth potential and drought tolerance traits of ponderosa pine will be used to refine seed transfer guidelines for the species, helping field foresters make informed seed transfer decisions.

BROADLEAVED SPECIES

Trees from a clonally propagated hybrid poplar stand near Vernon (Kamloops Forest Region) may be used in selected coastal and interior environments.

Background

There are several broadleaved tree species and hybrids of commercial importance in the B.C. interior. Some are used on a small scale for restoration, reforestation and reclamation projects. They also contribute to ecosystem complexity and stability. Very little is known about the genetics of these species and hybrids, so researchers have initiated a variety of tests to develop guidelines for their use in appropriate geographic ranges.

Summary

Researchers are conducting a series of broadleaf genetic studies in the interior of B.C. to explore the potential for using these species in various forest management strategies. Provenance testing and selective breeding of paper birch started in the 1990s. Measurements in 2000/01 (third year) suggest ample genetic variation in growth, which confirms that selective breeding could improve performance. An elevational transect seed source study was outplanted in 2000 to measure the influences of latitude, longitude, and nursery and planting location.

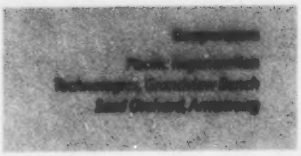
Researchers began testing hybrid cottonwoods, hybrid aspens and European silver birches in the interior in 1989. The results were lists of seed and vegetative lots recommended for use on Crown lands. Hybrid aspens have tested well in the southern interior, outperforming local native seed sources. Silver birch from the Finnish tree-breeding program has also tested well, showing greatest superiority over native paper birch in the Salmon Arm area. A 10-year-old silver birch trial has been thinned to provide a potential future seed source for some afforestation projects in the interior.

Results or products

Seed source testing and selective breeding of paper birch will provide field foresters with seed transfer guidelines and genetically improved planting stock. Testing of hybrid cottonwoods, aspens, and the exotic silver birch will generate lists of appropriate materials for private landowners to use in afforestation projects.

Cooperators

University of Northern British Columbia



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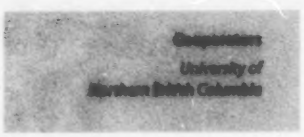


Research Support

BIOMETRICS

Background

Research undertaken by the ministry must follow sound principles of design and analysis to ensure that results are valid and credible. The Biometrics Unit provides advice and consultation to research scientists and other ministry staff on statistical procedures for research and operational needs, and for forest policy development. Topics include experimental design, sampling theory, and a broad range of statistical analyses.

Summary

Throughout 2000/01, the Biometrics Unit responded to direct queries from Forest Science Program researchers and other ministry staff about experimental design and data analysis. The unit also reviewed reports and articles for scientific journals to ensure the statistical validity of published work. In addition to its advisory role, the unit led or directly participated in:

- a provincial trial testing the feasibility of establishing and regulating area-based allowable annual cuts for woodlots,
- ongoing work on the newly established Vegetation Resource Inventory sampling procedure and ways to use inventory audit data,
- Research Branch's contribution to Forest Renewal BC's Operational Trial Protocol,
- comparing ecologically based and conventional site-index assignment methods on timber supply,
- an adaptive management project to examine forestry practices in pine-lichen winter range for northern caribou in the Omineca portion of the Prince George Forest Region,
- studying the use of small streams and forest gaps for breeding habitats by winter wrens in coastal B.C., and
- correlating silviculture surveys to determine whether they correctly identify sufficiently restocked or free-growing sites with the expected yields for lodgepole pine.

A tour at the Spey Creek site, west of Prince George (Prince George Forest Region), where birch, subalpine fir, spruce and Douglas-fir have regenerated after a wildfire some 40 years ago. Responses to several birch-harvesting intensities are being studied at this site.

Results or products

During 2000/01, biometrics staff visited regional offices to provide statistical support. They also instructed at The Forest Management Institute of British Columbia, and as part of the Temperate Rainforest Ecology course offered

Cooperators
Ministry of Environment, Lands and Parks

by the Western Canadian Universities Marine Biological Society. The unit also created a website to explain the woodlot licence area-based allowable annual cut trial (www.for.gov.bc.ca/research/woodlot/index.htm).

COMMUNICATIONS AND EXTENSION

Background

The Forest Science Program includes a range of services in communications and extension. These activities are designed to foster the incorporation of new knowledge and research results into ministry policies, planning, and management practices, and to increase the awareness of the program's products and activities.

Summary

During 2000/01, a poster display and brochure were produced to highlight the Forest Science Program research initiatives in silviculture, growth and yield, ecology, earth sciences and forest genetics.

In cooperation with the Southern Interior Forest Extension and Research Partnership (SIFERP), several two-day workshops, entitled "Decision Strategies for Complexity and Uncertainty," were presented to senior district, region and headquarters managers. This workshop was developed to address client needs on how to deal with organizational change. A second collaboration with SIFERP was a two-day "Extension Basics" workshop for Forest Science Program scientists and other specialists from affiliated organizations. The course gave participants background and extension skills that they can use to help clients integrate current research into their policies, plans and field practices.

At Lucille Mountain near McBride (Prince George Forest Region), consultants and researchers from the Ministry of Forests and the University of Northern British Columbia discuss reforestation issues.

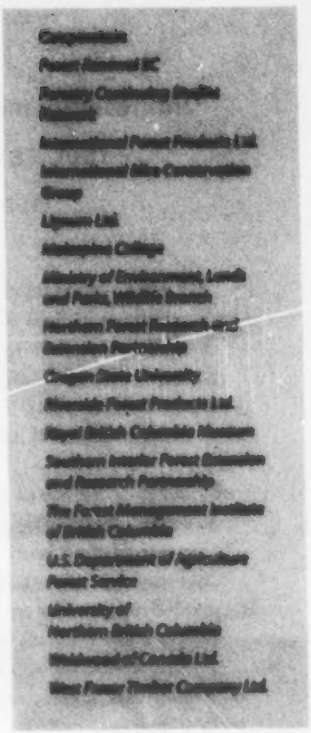
The program also published the third edition of the *Biodiversity Publications Catalogue*, in partnership with the Ministry of Environment, Lands and Parks, and the Royal British Columbia Museum. The catalogue includes an annotated list of more than 500 brochures, short summaries, books and in-depth reports about conserving biodiversity in B.C.

Regional and branch offices continued to improve and update their websites for content and navigation. Some additions were web pages on Biogeoclimatic Ecosystem Classification, the ministry's Growth and Yield Program, B.C.'s mountain forests, a hydrology abstracts library, and the application of IKONOS satellite imagery (IKONOS, the world's first commercial, high-resolution imaging satellite, was launched in September 1999).

Results or products

Forest Science Program researchers communicated their findings to a diverse client base using publications that ranged from scientific papers to operationally oriented extension notes. The publications list on page 43 shows the many valuable contributions program scientists made to the natural resource management community during the past year.

Program scientists took the lead or contributed to many workshops and technical meetings this year dealing with boreal mixedwoods, range management, wetlands, coastal forest rehabilitation, dry-forest ecosystems, soil rehabilitation and protection of small fish-bearing streams. Researchers also shared their expertise in a variety of forestry-related subjects as instructors in colleges, universities and educational organizations, such as The Forest Management Institute of British Columbia.



INFORMATION MANAGEMENT

Background

The aim of information management is to share Forest Science Program information both internally, with other ministries and federal government agencies, and with external organizations that use forestry science and technology information. In recent years, B.C.'s forest practices have corne under increasing scrutiny by local, national and international interests. This creates an urgent need to make available the science behind those decisions. The information must be credible, thoroughly referenced, and readily accessible to all interests. Managing the information generated by the Forest Science Program is the primary function of the Information and Data Management Unit.

Summary

One of the mechanisms we use to share information externally is the online Natural Resources Information Network, which is a collaborative initiative of the Southern Interior Forest Research and Extension Partnership and other natural resource agencies in B.C., including the Forest Science Program. By being a partner in the technical development of the network and providing a catalogue of our information assets, the Forest Science Program is building an online environment that provides links among the natural resource agencies, decision-makers and communities.

Cooperators
Ministry of Environment, Lands and Parks

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Cooperators

Forest Renewal BC

Forestry Continuing Studies Network

International Forest Products Ltd.

International Mire Conservation Group

Lignum Ltd.

Malaspina College

Ministry of Environment, Lands and Parks, Wildlife Branch

Northern Forest Research and Extension Partnership

Oregon State University

Riverside Forest Products Ltd.

Royal British Columbia Museum

Southern Interior Forest Extension and Research Partnership

The Forest Management Institute of British Columbia

U.S. Department of Agriculture Forest Service

University of Northern British Columbia

Weldwood of Canada Ltd.

West Fraser Timber Company Ltd.

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In the Merritt Forest District (Kamloops Forest Region), a soil scientist provides soil conservation training to ministry and industry staff.

Cooperators

Canadian Forest Service

Land Use Coordination Office

Southern Interior Forest Research and Extension Partnership

Results or products

In 2000/01, the focus was on developing the Forest Science Program knowledge management framework and integrating it with other organizations. The unit developed a metadata (i.e., information cataloguing) structure and the information systems architecture. The latter will support the knowledge management framework and advanced systems applications needed for the changing scientific and business requirements of the Forest Science Program.

In another project, the unit updated capability and capacity for the landscape habitat and growth and yield modelling business areas.

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Forest Science Program Publications[2]

April 1, 2000 to March 31, 2001

BY MAJOR DISCIPLINE AND SUBACTIVITY

SILVICULTURE: 1. SILVICULTURE SYSTEMS

Andrews, C. 2001. Case Study: using partial cut timber harvesting methods in a sensitive watershed in southeastern B.C. B.C. Ministry of Forests, Nelson Forest Region. Extension Note 56[3]. 4 p.

Coates, K.D. 2000. Conifer seedling response to northern temperate forest gaps. Forest Ecology Management 127:249–269.

DeLong, D., P.G. Comeau, I. Cameron, D.G. Simpson, R. Adams and E. Fanjoy. 2000. How light conditions affect tree seedling performance in the Interior Cedar–Hemlock Subzone: Preliminary Results-EP 1191. B.C. Ministry of Forests, Nelson Forest Region. Extension Note 50. 4 p.

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Gibson, J.J., J.S. Price, R. Aravena, D. Fitzgerald and D. Maloney. 2000. Runoff generation in a hypermartime bog-forest upland. Hydrological Processes 14:2711–2730.

Gribbon, P., L. Waters and D. Delong. 2001. Using alternatives to clearcutting in viewscapes: Case study in the Columbia Forest District in southeastern B.C. B.C. Ministry of Forests, Nelson Forest Region, Nelson. Extension Note 53. 6 p.

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Klenner, W., R. Walton and W. Kurtz. 2000. Habitats for tomorrow: Understanding the consequences of today's decisions and natural disturbances on future habitat condition. *IN*: Ibid. pp. 199–206.

Kranabetter, J.M. and A. Banner. 2000. Selected biological and chemical properties of forest floors across bedrock types on the north coast of British Columbia. Canadian Journal of Forest Research 30:971–981.

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Krasowski, M.J. and D.G. Simpson. 2001. Frost-related problems in the establishment of coniferous forests. pp. 253–285. *IN*: F.J. Bigras and S.J. Colombo, Editors. Conifer Cold Hardiness. Kluwer Academic Publishers, Dordrecht, The Netherlands. 596 p.

LePage, P., C.D. Canham, K.D. Coates and P. Bartemucci. 2000. Seed abundance versus substrate limitation of seedling recruitment in northern temperate forests of British Columbia. Canadian Journal of Forest Research 30:415–427.

Prescott, C.E., L.L. Blevins and C.L. Staley. 2000. Effects of clear-cutting on decomposition rates of litter and forest floor in forests of British Columbia. Canadian Journal of Forest Research 30:1751–1757.

Waterhouse, M., N. Daintith, O. Steen and H. Armleder. 2001. Itcha-Ilgachuz Alternative Silvicultural Systems Project: Microclimate, planted stock and natural regeneration. B.C. Ministry of Forests, Cariboo Forest Region, Williams Lake. Extension Note 35. 4 p.

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strategies on long-term site productivity in lodgepole pine forests of the central interior of British Columbia. Forest Ecology and Management 133:217–229.

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DeLong, C. 2000. Planting white spruce under trembling aspen: 7-year results of seedling condition and performance. B.C. Ministry of Forests, Forest Science Program, Victoria. Working Paper 54. 19 p.

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Thomas, K.D., P.G. Comeau and K.R. Brown. 2000. The ecology and silviculture of hybrid poplar plantations. B.C. Ministry of Forests, Forest Science Program, Victoria. Extension Note 47. 7 p.

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de Montigny, L. and S. Stearns-Smith. 2001. Pruning density and severity in coastal Douglas-fir near Chilliwack, B.C.: 8-year results. B.C. Ministry of Forests, Forest Science Program, Victoria. Extension Note 56. 6 p.

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Biring, B.S. and W. Hays-Byl. 2000. Ten-year conifer and vegetation responses to glyphosate treatment in the SBSdw3. B.C. Ministry of Forests, Forest Science Program, Victoria. Extension Note 48. 6 p.

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Simard, S.W. and K.D. Hannam. 2000. Effects of thinning overstorey paper birch on survival and growth of interior spruce in British Columbia: Implications for reforestation policy and biodiversity. Forest Ecology and Management 129:237–251.

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Biogeoclimatic Ecosystem Classification Definitions

The Biogeoclimatic Ecosystem Classification (BEC) terms used in this publication are defined below. A complete listing of all BEC terms is available at www.for.gov.bc.ca/research/becmaps/becappen.txt

ESSF			**Engelmann Spruce–Subalpine Fir**
	ESSFmm		Moist Mild ESSF
	ESSFxv		Very Dry Very Cold ESSF
		ESSFxv2	West Chilcotin Variant ESSFxv
ICH			**Interior Cedar–Hemlock**
	ICHmc		Moist Cold ICH
		ICHmc2	Hazelton Variant ICHmc
	ICHmm		Moist Mild ICH
	ICHmw		Moist Warm ICH
		ICHmw2	Columbia-Shuswap Variant ICHmw
IDF			**Interior Douglas-Fir**
	IDFdk		Dry Cool IDF
		IDFdk1	Thompson Variant IDFdk
		IDFdk2	Cascade Variant IDFdk
		IDFdk3	Fraser Variant IDFdk
		IDFdk4	Chilcotin Variant IDFdk
	IDFdm		Very Mild IDF
		IDFdm2	Kootenay Variant IDFdm
	IDFxm		Very Dry Warm IDF
MH			**Mountain Hemlock**
MS			**Montane Spruce**
	MSdk		Dry Cool MS
PP			**Ponderosa Pine**
SBS			**Sub-Boreal Spruce**
	SBSdk		Dry Cool SBS
	SBSmw		Moist Warm SBS

How to Contact Us

We welcome your comments and questions about the Forest Science Program at the Ministry of Forests, and invite you to contact us by telephone, mail, fax or email. Or visit our websites for a list of publications, project summaries and other information.

RESEARCH BRANCH HEADQUARTERS

Location
712 Yates Street
Victoria, BC V8W 1L4
Phone 250 387-6721
Fax 250 387-0046
www.for.gov.bc.ca/research

Mailing address
P.O. Box 9519 Stn Prov Govt
Victoria, BC V8W 9C2

RESEARCH STATIONS

Research Branch Laboratory
Location
4300 North Road
Victoria, BC V8Z 5J3
Phone 250 952-4136
Fax 250 952-4119

Mailing address
P.O. Box 9536 Stn Prov Govt
Victoria, BC V8W 9C4

Cowichan Lake Research Station
Box 335 7060 Forestry Road
Mesachie Lake, BC V0S 2N0
Phone 250 749-6811
Fax 250 749-6020

Kalamalka Forestry Centre
3401 Reservoir Road
Vernon, BC V1B 2C7
Phone 250 260-4755
Fax 250 542-2230

REGIONAL FOREST SCIENCE OFFICES

Cariboo Forest Region
200 - 640 Borland Street
Williams Lake, BC V2G 4T1
Phone 250 398-4345
Fax 250 398-4380
www.for.gov.bc.ca/cariboo/research/research.htm

Kamloops Forest Region
515 Columbia Street
Kamloops, BC V2C 2T7
Phone 250 828-4131
Fax 250 828-4154
www.for.gov.bc.ca/research/kamloops/index.htm

Nelson Forest Region
518 Lake Street
Nelson, BC V1L 4C6
Phone 250 354-6200
Fax 250 354-6250
www.for.gov.bc.ca/nelson/nel_r.htm

Prince George Forest Region
1011 4th Avenue
Prince George, BC V2L 3H9
Phone 250 565-6100
Fax 250 565-4349
www.for.gov.bc.ca/pgeorge/pgeo_r.htm

Prince Rupert Forest Region
Bag 5000 3726 Alfred Avenue
Smithers, BC V0J 2N0
Phone 250 847-7500
Fax 250 847-7217
www.for.gov.bc.ca/prupert/research/index.htm

Vancouver Forest Region
2100 Labieux Road
Nanaimo, BC V9T 6E9
Phone 250 751-7001
Fax 250 751-7190
www.for.gov.bc.ca/vancouvr/research/research_index.htm

Endnotes

1 For BEC terms, see the "Biogeoclimatic Ecosystem Classification Definitions" section, page 51.

2 "Extension Notes" are published by Forest Science Program sections in individual forest regions and by the Research Branch in Victoria. All use an ascending numbering system, so there may be, for instance, an Extension Note 30 from more than one source. To find a particular reference, refer to the region or branch specified in the citation.